DEVELOPMENT OF HUMAN SETTLEMENT PATTERN IN PERI-URBAN AREAS OF WEST BENGAL IN THE CONTEXT OF GROWTH, GOVERNANCE AND GLOBALISATION

Thesis Submitted By

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"STATEMENT OF ORIGINALITY"

I **Debarati Chakraborty** registered on **29.10.2013** do hereby declare that this thesis entitled **"Development of Human Settlement Pattern in Peri-Urban Areas of West Bengal in the Context of Growth, Governance and Globalisation"** contains literature survey and original research work done by the undersigned candidate as part of Doctoral studies.

All information in this thesis have been obtained and presented in accordance with existing academic rules and ethical conduct. I declare that, as required by these rules and conduct, I have fully cited and referred all materials and results that are not original to this work.

I also declare that I have checked this thesis as per the "Policy on Anti Plagiarism, Jadavpur University, 2019", and the level of similarity as checked by iThenticate software is _10___%.

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CERTIFICATE FROM THE SUPERVISOR

This is to certify that the thesis entitled **"Development of Human Settlement Pattern in Peri-Urban Areas of West Bengal in the Context of Growth, Governance and Globalisation"** submitted by **Smt. Debarati Chakraborty,** who got her name registered on **Date- 29.10.2013** for the award of **Ph. D. (Engineering)** degree of Jadavpur University is absolutely based upon her own work under the supervision of **Tapas Kumar Bhattacharyya,** and that neither her thesis nor any part of the thesis has been submitted for any degree/diploma or any other academic award anywhere before.

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1. Introduction

1.1. Background

In India, metro cities have indicated a higher growth in urban population in the past decade. There are 7 mega cities (4 million plus) and 28 metropolitan cities in the country. As a result, the urban population has increased much quicker than the cumulative and rural populations. Furthermore, its share of the overall population has soared from 10.85 % in 1901 by about 27.78 % in 2001.

Rapid urban development and increasing land use changes due to increasing population and economic growth in developing cities need attention of the physical planners. Increasing congestion in cities because of increase in population and in migration owing to urbanisation has resulted in deformation of growth of cities. The cities are expanding in all directions resulting in large-scale urban sprawl and changes in urban land use. During the phase of rapid expansion, the largest share of total growth is accounted by the fringe area as urban sprawl, ribbon development, or leapfrog development. The actual impact of such shifts on spatial structure seems to be fully evident on the urban countryside or city peripheral rural regions, than in the central city. Unknowingly, this is leading to an increase in built-up area and modifications in spatial urban land use patterns, leading to the loss of productive farmlands, forestland, as well as other forms of vegetation, loss of waterbodies, depletion of groundwater sources, and rising levels of air and water pollution.

Peri-Urban territories can possibly assume a positive part in upgrading urban supportability at worldwide level. This is on the grounds that urban communities in all nations need to confront the difficulties presented by endless suburbia. The cycle of urbanisation will keep on developing exponentially in the coming decades.

There are numerous definitions related with peri-urban zones. The normal element of the peri-urban territory is that they are “in transition phase” spaces with some level of mixing of urban and country employments. There is an especially solid distinction between the peri-urban regions of developing nations described by contamination of land and streams, destitution and casual settlement; and those of developing nations of Europe portrayed by low degrees of portability, monetary execution, scene honesty and ecological quality. Inside both the developed and developing nations, we should perceive the variegated idea of the region and the assortment of peri-urban territories it contains.

In light of the changeability of the thought we can say that peri-urban regions are by and large to be found at the urban periphery along the edges of the developed region and will in general include a dispersed example of lower thickness settlement and urban focuses around transport centre points. Peri-urban territories might be prevalently huge green open spaces, for example, urban forests, farmland and nature holds in the urban fringe with a lower populace thickness yet having a place practically with the urban region. Peri-urban might be a zone of littler settlements, modern territories and other urban land-utilizes inside a network of useful urban agriculture and aqua-agriculture.

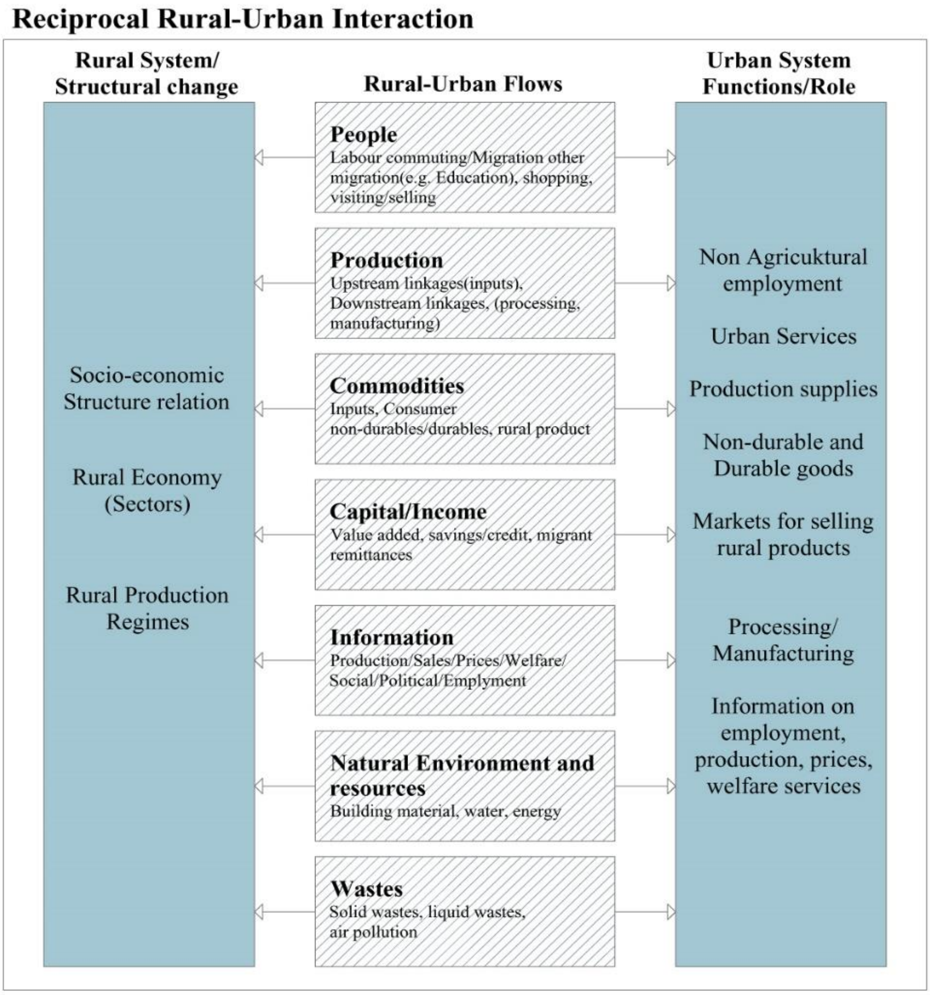


Figure 1. 1: Reciprocal Rural Urban Interaction, Source: Author.

Before 1990s the growth of Indian cities primarily driven by large scale migration from rural to urban areas and natural growth of population. But the growth of urban population largely confined within the territorial limit of the city resulting in overcrowding of these urban areas and sprung of informal settlements/slums. This pattern of urban growth changed significantly after the economic liberation, since then outward expansion of the existing cities emerged as the major component of urban growth. As a consequence of the intense outward expansion of the cities, rapid changes in land use and occupation have transformed the adjoining rural hinterland into semi urban or peri urban areas. Contemporary India’s urban policies and programme (such as JNNURM[1]) and of more recent one like Smart City Project have supported metropolitan based ‘polarised growth’. Lateral extension of the Indian cities has attracted attention of scholars very recently (Shaw & Sykes, 2003). The outward expansion of the cities beyond their territorial limits has resulted in mixed land use which are neither rural nor urban. These transition areas are popularly known as peri-urban. This terminology is derived from the word ‘peripheral’. Effectively, these words also convey meaning of being less important, incidental to main activities, outer edge fringe to the main, spill over or overflown. 'Peri-urban' has come to serve as a conceptual term to denote the intervening region between 'rural' and 'urban,' and that is a

[1] Jawaharlal Nehru National Urban Renewal Mission

geographic location where the rural converges with the urban. (Narain, Khan, Sada, & Singh, 2013).

Recently, peri-urban areas of Indian metros (i.e. million plus cities) extensively studied in the Indian literature, although the peri-urban areas are not exclusive to metros only. The small and medium sized towns are also playing a vital role in the process of peri-urbanization in India but are not taken into account in the literature. This procedure is spreading rapidly in certain micro and large cities, based on their position and unique attributes (Dadras, Safarpour, & Dehgani, 2015). The Peri urban growth of Indian cities results in sprawl by which the rural land uses are completely or partially transformed into urban uses. The sprawl is occurring at an unprecedented rate, but in unregulated and unplanned manner in response to intense peri-urbanisation. From this perspective urban sprawl can be visualized as dispersed growth of settlements in the Peri urban areas. This rapid sprawling demanded immediate interventions to mapping and monitoring by employing advanced remote sensing techniques.

In West Bengal the governance system took initiative in decentralising the population growth happening inside and the surrounding of the city resulting in uneven/diffused settlements. What did decentralisation mean for the Left Front government in West Bengal? Which of its qualities differs from the ordinary understanding of the word? To begin with, the policy of decentralising decision-making was designed largely for rural West Bengal. As a result, decentralised planning in West Bengal's urban regions was not by design, but rather as a result of rural self-government. In West Bengal, decentralisation is more or less equated with local representative/electoral democracy. In West Bengal, participatory democracy is still in its infancy. There has been a systematic rural bias in India since independence, not just in West Bengal but across the country. 85% of India's population lived in rural areas at the time of independence. For politicians and economists, rural poverty was perceived as a greater challenge. Urban areas' challenges were rarely acknowledged (Burra, 2005).

After independence, the country's administrative system was created with the enormous rural population in mind, with little care given to urban administration. Decentralisation tests started in West Bengal in the late 1960s, only when Communist-led United Front coalition momentarily came to power and attempted to adopt a policy of huge agricultural land transition in rural areas. 'The method of decentralisation in West Bengal happened by chance instead of design [referring to the CPIM's - election victory], and it started in the rural areas.' For a long period of time, urban organisational needs, particularly in metropolitan areas like Kolkata, barely changed from whatever the British administration might have left behind. There was a serious effort in the West Bengal legislature to execute the strategy in urban areas until after the 74th CAA[2], when the West Bengal Municipal Act 1993 was approved.

Not only does West Bengal lack the civil society infrastructure but also needed to engage multiple organisations at the city or regional scale, but experts, planners, and policymakers have displayed negligence in engaging non-partisan civil society organizations in the strategic

[2] Constitutional Amendment Act

planning. The failure of the centralised planning strategy to improve the living environment and service delivery was the first push for further decentralisation in KMDA[3]'s planning process. The initial development of planning process for the KMDA was based on a fundamental comprehensive planning paradigm, in which "specialists" armed with statistics as well as prognostication tools made the decisions on land use and infrastructural developments with hardly any (or no) insight from local communities or end users. During an interview, the KMDA's Director (Microfinance) suggested the following causes of failure of this sort of planning method. For starters, it did not comply with local needs and requirements. Second, municipalities had been assigned the task with controlling and maintaining KMDA-built infrastructure, but they failed to take responsibility (in terms of accountability) of such initiatives because they've never been added to the original planning process. As a consequence, many of the projects began to collapse and ultimately disappeared completely. As a matter of fact, he blamed these same weaknesses in the preceding strategic planning on the KMA's decentralised and collaborative planning approach. This concept of participation, which was mostly associated with development projects, was intended to improve project efficacy and efficiency, as well as, in some situations, to encourage cost-sharing. These project-related goals or justifications for participation have been referred to as "instrumental" or "means to an end" (Béné, et al., 2016). This logic differs dramatically from the NGO sector's long-held belief in empowerment and capacity building through involvement. This second line of logic perceives participation as an objective in and of itself, but one which leads inevitably to those other successful effects such as liberation and infrastructure building, enabling populations to go about their everyday lives while still partaking more efficaciously in project related public debates.

1.2. Relevance of the topic

The peri-urban – the space round the urban regions which blends also with hinterland – is constantly developing. Nevertheless, while most urban areas nowadays are slowly increasing (at 0.5-0.6 percent per year), human habitation growth in peri-urban regions is increasing four times greater comperatively.

The repercussions of such fast expansion are multiple. In several cases, the outcome is sprawl, with soaring problems of social discrimination, urban decay, unclaimed land, and reliance on oil for mass transit. There really are, however, instances of alternative solutions, such as possibilities for improved standard of living, green infrastructure, better linkages among metropolitan area and hinterland, and more efficacious urban and rural development.

All in all, the peri-urban issues need to be addressed at the strategic level of the neighbouring 'rural-urban region.' More impactful local authority, along with fresh patterns of social enterprise and cooperation, are needed for integrated planning (i.e. joined-up policy) throughout rural-urban guidelines framing.

[3] Kolkata Metropolitan Development Authority

The formation of human settlements as studies from various datasets in West Bengal absolutely conforms to sporadic non planned ones. The Human Settlements generated on the first half of the last century was not controlled by governance whereas on the latter half governance played a major role in controlling the socio - economic challenges in the newly developed settlements. Growth in population ushered in along with the new built-up developments and the fabric changed its face due to getting affected by globalisation.

This research focuses on all-encompassing example of urban sprawl of Kolkata Urban Agglomeration around 2.5 km from its outer limit of official jurisdiction. Its land use analysis has revealed a decline of water bodies from 23.61% (1991) to 6.69% (2011). During 2011 the built up had constituted 32.51%, vegetation comprised of 30.43%, whereas vacant land and agricultural land made up about 19.68% and 10.69% respectively. Increased Shannon’s entropy during 2011 highlights the tendency of sprawl that necessitated policy interventions to provide basic amenities. Spatial pattern through metrics indicated a compact and simple structured growth at the centre of the Kolkata and a distributed complex shape in the buffer region. Further the metrics indicated that the municipalities are on the verge of becoming a single large urban patch that would affect their ecological integrity. Temporal analysis of spatial pattern of urbanisation helps the municipal administration and town planners to visualise and understand the growth of the ULBs so that they can provide better resource planning to create an effective urban region (Mosammama, Niaa, Khanib, Teymouria, & Kazemi, June 2017).

Land in the peri-urban interface is of imperative significance as there is an absence of lucidity in the arranging and strategies in this area whether they ought to be administered under the authority of provincial organisation. When all is said in done, these regions are as often as possible disregarded as a particular region in the investigation of urbanisation being neither unadulterated urban nor unadulterated provincial. In such manner, an endeavour has been taken to recognize the Spatio-worldly elements of spread, the idea of land use change occurred in the distinguished fringe settlements with high likelihood of urban advancement inside the cushion zone of 5 km around the limits Kolkata in the urban assemblages of Kolkata Metropolitan Area.

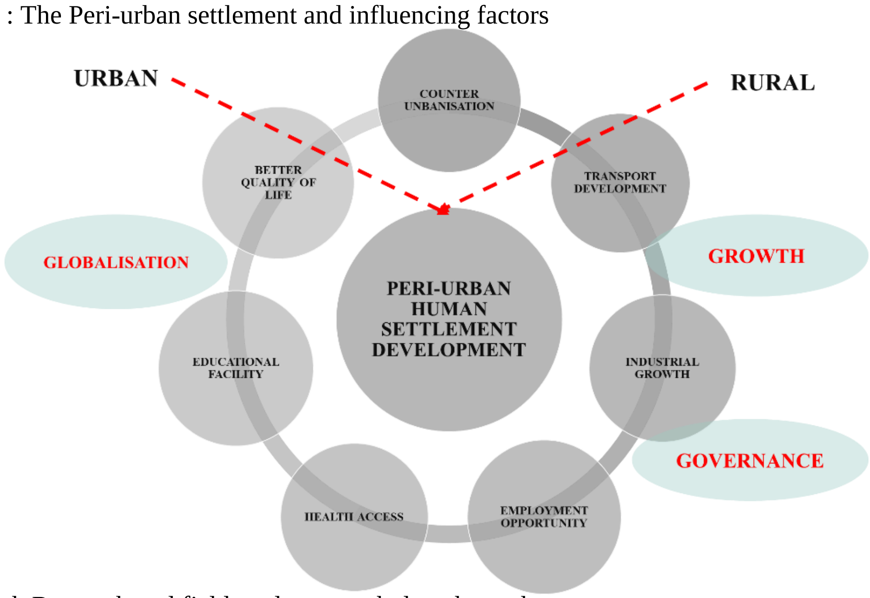
1.3. Problem Statement / Scenario analysis

In the post-Independence era along with massive pressure from partition a sudden surge of population influx happened towards Kolkata from mostly the side of Bangladesh. With the rising scenario of job opportunity, academic facility, healthcare access, and industrial growth in and around KMA region ushered in a large amount of population drift from rural areas to the City. Due to the high living cost, this mass of population started finding something cheaper surrounding the city, hence started the peri-urban developments with new human settlements. Along came refugees and immigrants who settled in the newly created habitats in the suburbs- all said and done in an unplanned way.

In the late 80’s the housing development authorities started investigating into the then recent boom in housing demand over the peri-urban areas of KMA. Found out, the interest of public in better quality of life in affordable prices were only available in the peri-urbans. The transition between rural and urban fabric of KMA and surrounding areas started to blurred out in an incomprehensible frequency.

Along with the latter half of 90's the transport system, mode of conveyance augmented and the city started to grow along its transport corridors. Counter Urbanisation happened joining the chain of urban sprawl with the spot development of Peri-urban areas. The link created was heavy, sporadic, and somewhere hazy, with no demarcation between urban and rural, loss of hope for better quality of life and services, losing on the essence of quality of human life and its environment in evolving human settlement patterns or growth of Peri-urban Human Settlement (Fig. 1.2).

Figure 1. 2 : The Peri-urban settlement and influencing factors



Source: Desk Research and field study research done by author

So that now growth happened, along came in Globalisation. With technology, new industries, and network, the settlements in peri-urban areas of KMA suffered from ultimate pollution, heavy traffic, congested development due to demand and supply chain, and waste generation problem.

Governance/ Local Body Authorities were either naïve or not equipped with proper planning tools or manpower or had implementation failure or failure to launch an effective development programme in these areas, the time that it demanded a kin attention on the same.

COVID19 is currently the leading city and regional planner the planet has seen since. Peri urbanism would therefore glow, and provinces will develop. One is about to renounce major metropolitan infrastructure improvements projects in pursuit of making an investment in future adaptable neighbourhoods where people look out for one another.

And that's an idea which has been derived by widely respected town planners across the globe who've already contributed in city planning for both massive metropolitan areas and developments all around the world. The ironic part is – and that they are correct – that it has taken a global pandemic to knock us all out of our obsessive focus on centralised, high density urban cores encircled by only residential areas. Peri-urban regions from which employees would drive to work to their town offices on a daily basis, preferably via high-volume public transit. Our acquiescence demanded that infinite amounts of public funds be thrown at inner-city cores, satisfying the increasingly privileged professional clergy who enjoyed the rewards of surging housing prices while Peri urban areas worsened.

But the lure of the city was always a delusion. Growth of population have collectively developed a fixation on our CBDs and inner-city areas as economic drivers of employment. While they are very significant in size, they are not dominant relative to the spatial distribution of jobs throughout metropolitan areas. If the evidence is clearly pointing to cities with employment overwhelmingly located in Peri-urban locations, and points to this trend continuing, it is possible that a variety of public policy settings or governance would need resetting given the realities of our urban environment. It is equally possible that opportunities for growth and globalisation to meet market demand for employment lands in Periurban locations have not yet been fully captured.

There seem now to be no shortage of publicly funded initiatives focused on delivering a better quality of urban existence within a five-kilometre ring of the city, and too few to focus on the hard and soft infrastructure deficits that our Periurban areas are still living with.

However, no end of evidence or public debate was sufficient to wrest the planning orthodoxy from their centralised vision of the inner urban economy and its elites living, working, and playing within a hazy 5-kilometre ring of a metropolitan area.

Even obvious policy failures – rising congestion, chronic infrastructure lags and falling quality of life – did not test the faith of planners and pundits in the religion of centralisation. Vision 2025 CMA prepared by Kolkata Metropolitan Development Authority plunge into the problems of overcrowding and infrastructure inadequacies in and around KMA and prompted the all the Planning Institute of the State to respond with the suggestion that what was needed to fix the problems caused by centralisation and density by pushing more centralisation and density: “We want London, Paris, and New Yorks – and we can do that by planning well.”

Property industry leaders who once worshipped at the altar of centralisation have sniffed the winds and seen hope of new salvation in the suburbs. Fund managers are predicting a significant fall in demand for CBD offices as workers adopt more amenable work-life practices – working from home or from suburban hubs. The Policy makers are predicting a paradigm shift of the entire metropolitan economy away from CBDs to more suburban locations.

The area of KMA is the nerve centre of the socio-economic and political life of the state of West Bengal. Today it is among the fastest growing metropolitan cities of India. Rapid social change has forced small agricultural communities to adjust to an urban or industrial way of life in a very short time. The urban growth dynamics consists of increasing intensity of use of land in already developed areas, filling of undeveloped pockets of land within the developed areas, development on the periphery of developed areas, and merger of outlying settlements as the developed areas expand. Most of the time, especially during the phase of rapid expansion of the city, the largest share of total growth is accounted by the development in the fringe areas. Environmental stresses in peri-urban areas of the city of Kolkata inside the boundary of KMA in West Bengal are related to the spread nature of peri-urban settlement, pollution from a variety of industrial and residential sources, increase in traffic on roads & inadequate infrastructural resources to cope with the rapid development.

Following issues have been distinguished as topics for research. The first of these concerns the need to refine the concepts relating to peri-urban urbanisation with immediate effect of *growth, governance and globalisation*. Land-use issues and the pressing problem of how land degradation should be interpreted in a rural-urban fringe. How local and extra-local influences interact to determine land-use patterns in the peri urban areas.

Thus, this research focuses on finding out the correlation and impacts of urban growth, governance and globalisation in order to promote effective development of human settlement in the peri-urban areas of West Bengal (Surrounding KMA).

1.4 Structure of thesis

Chapter one describes the study perspective & background analysis, which finally led to research concerns, subsequent formulation of objectives and the utility of the research.

Chapter two includes the necessary literature review & case studies to support the core research problems for formulation of research objectives based on effective development of human settlement pattern in peri-urban areas.

Chapter three focuses on to the need of the study, aims, objectives, scope, research questions, and describes the methodology used, from case studies, the pool of relevant data and tools and techniques employed in the research.

The results and interpretation of the peri-urban location, as revealed by statistical calculation in West Bengal and therefore delineation of study area within West Bengal are presented in chapter four.

The results and interpretations of the assessment of LULC changes in KMA with weightage index calculation, composite score analysis of different growth indicators, identifying regional micro level study areas in KMA are presented in chapter five.

The examination of the nature and level of planning and urbanisation in identified micro level study areas, through Chi-Square, Shannon’s Entropy & LULC projection is summarised in chapter six.

Chapter seven focuses on key tactics and long-term suggestions based on an analysis of observed patterns of human settlement in peri-urban areas driven by growth, governance and globalisation.

Finally, the chapter eight concludes the current research's utility, way forward as well as its limitations and the scope of future research.

2. Literature Review and Case study

The present chapter provides a review of literature on the interrelationship of human settlement pattern generation in the adjacent peri-urban areas with the interference of growth, governance and globalisation in the context of a metropolis. The purpose of the review is to identify the key factors affecting pattern generation and subsequently forward a simplified approach for an inclusive assessment for developing guidelines for human settlements around metropolis. This chapter presents the review in two sections:

In section one (the contextual study), identification, sorting, organization, interpretation, consolidation, and communication—of this research work, the activity data gathered, for the purpose of understanding the work and the relation between major key factors like settlement generation in the volatile peri-urban areas, the affecting factors of growth, governance and globalisation, and argument emphasizing need for an inclusive assessment is gradually built and forwarded.

In section two (the case studies and desk research), the already existing models in global, Indian and Regional Context have been studied and the best possible theories and models pointed out to address the present research concern.

Accordingly, the review of literature proceeds from the general or exclusive premise of peri-urban development assessment to a larger or inclusive domain of peri-urban development assessment, which underscores the key concern of the present research. The aim of the literature review is to arrive at an understanding of the impact levels of growth, governance and globalisation on evaluation of peri-urban human settlement development pattern for comparing the present and future guidelines and development control rule for effective human settlement pattern development surrounding a metropolitan area.

2.1 Contextual Study

2.1.1 Human Settlement Pattern & Growth of Cities

Ekistics theory: Ekistics theory is a theory developed by Doxiadis to explain settlement (human settlement). A human settlement is a human-inhabited area that includes both content and container elements. Nature (human), human (Anthropos), society (society), reflection (shells), and networks are the five components of ekistics (networks). (Farizkha, Koesoemawati, Suprobo, & Listyawati, 2019)

a. Natural: Nature is the first element of settlement due to several reasons, namely nature is the oldest element compared to settlement, after those settlements are formed by nature which produces a system. Theoretically, it can be said that settlements are part of nature. The research was carried out by looking at natural elements related to physical appearance of the earth, availability and ability of the environment.

b. Human: Humans are the second element of the ekistics element, which follows nature but escorts three other elements. Humans began by altering nature by erecting huts. Following that, began to gain expertise in the agricultural revolution, which resulted in the creation of various types of houses. The human element examined in research is related to the conditions, numbers, and relationships between individuals.

c. Community: A society is a network of people who form a kinship system. To understand society as an element of settlement, consider its relationship to physical environmental conditions such as nature, protection, and networks. This study investigates societal elements through sub-variables in the form of social conditions that exist within the scope of settlements (such as livelihoods, income, education level, economic conditions and cultural characteristics that exist in the community in the scope of the research room)

d. Protection: In this case, protection or shells are interpreted as conditions, types, and home services. There are several types of protection, including education, health, administration, security, industry, storage, and others.

e. Network: The network is a utility aspect that includes transportation, electricity, and water facilities, among other things. Humans use and utilise all types of networks as a residential support facility. The availability of the network, particularly the transportation network, which contributes to occupancy access to centres of activity, and clean water networks as a means of basic human needs, will be considered in the selection of a comfortable settlement.

Gravity; biology; physiology; social; movement; inner structure; external structure; growth; organisation; geographical are the major forces of ekistics synthesis.

Settlement development theory: Settlements are a part of the environment in protected areas, both urban and rural, and serve as neighbourhood units of residence or residential neighbourhoods, as well as places of activity that support per life and livelihood. Settlement development can be interpreted as an increase in the size of the residential environment caused by an increase in the population and an increase in the community's economy, resulting in an increase in the demand for housing needs. The selection of a settlement location is primarily influenced by factors such as location factors, the completeness of facilities and infrastructure, and the community's environmental conditions.

City morphology and settlement growth: Human settlement is a type of human habitation that can range from a single home to a large city. In other words, it is the process by which people open up and settle in previously uninhabited areas. People live in communities of houses that could be a village, town, or city. Human settlements are fundamental to human geography because the type of settlement in any given region reflects the human relationship with the environment. A human settlement is defined as a place that is inhabited on a permanent or semi-permanent basis. Houses can be designed or redesigned, buildings can be altered, and functions can change, but settlement persists in time and space.

Morphology literally means "the science of form." Morphology is the study of forms and shapes from neighbourhoods in urban contexts. A form is a visible form that is a configuration of several objects, whereas a shape is a geometric feature or an external form and an outline of an object. The settlement environment becomes an important keyword because it is stated in the science of city planning and design that civilization begins with settling activities. The complexity of settlement growth leads to the formation of larger environmental units, namely cities. As a result, the city environment cannot be separated from its surroundings. As a result, it is possible to conclude that the development of a good city must start with good settlement planning. If settlement growth can be controlled with certain treatments, the formation of an urban area will proceed smoothly and in accordance with the principles of effective development. The road pattern is the most influential aspect of city morphology. There are three (three) known types of road pattern systems, namely: (1) an irregular road pattern system (irregular system); (2) a concentric radial road pattern system (radial concentric system); and (3) an elbow angle or grid system (rectangular or grid systems) (Fig: 2.2, 2.3). Observing morphological components can help one understand the city's growth and development. Land use, buildings, plots, and road networks all have an impact on regional growth, both functionally and economically. Urban areas are made up of a network of activities that are intricately linked by movement networks. The interaction of these two systems, the activity system and the movement system, results in urban areas having economic or property values, the distribution of which is heavily influenced by natural physical characteristics and the support of the two systems. Map science can help us observe city growth geographically (cartography). The distribution of natural and artificial physical potential can be easily observed and analysed using maps. Land use, building density, land size and control, and the road network can all be mapped and explained logically in relation to one another.

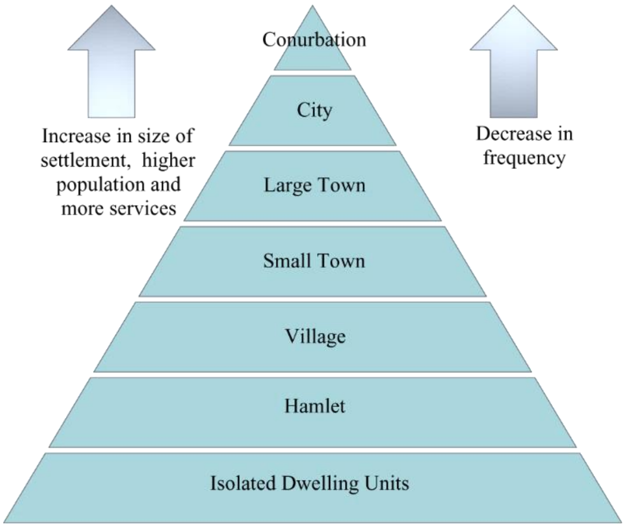


Figure 2. 1: Categorisation of settlements. Source: https://www.geographypods.com

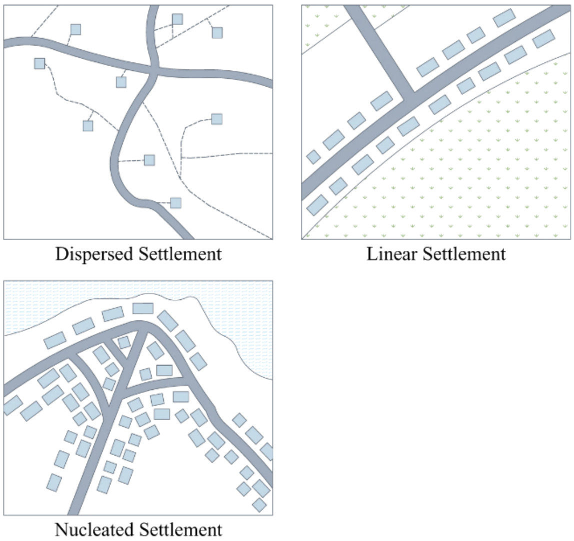


Figure 2. 2 : three major categories of human settlement pattern. Source: https://www.geographypods.com

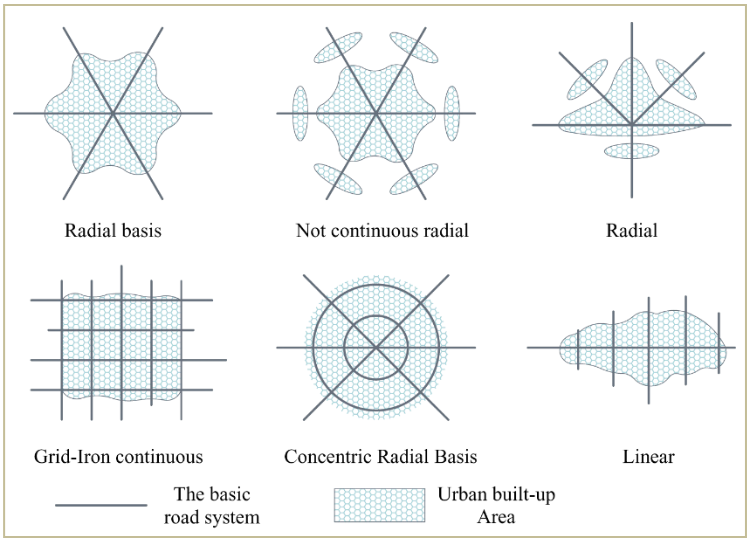


Figure 2. 3 : Six Patterns of Physical Development of Urban Settlements According to Branch (1995)

2.1.2 Urbanisation, Urbanisation Indicator & LULC change

Urbanisation: urbanisation is a result of population shift to towns and cities. Population increase and urbanisation are primarily the outcome of individuals moving from rural areas to urban ones. These population shifts have a ripple effect on land use, economic activity, and culture. City growth in the past has sparked enormous economic and social changes. Such factors as better health, decreased fertility and a longer life expectancy are all associated with urban living. There is also more access to social services and more chances for cultural participation in cities (UNDESA, 2014). As a result of rapid and unplanned urban growth, deficient infrastructures such as housing, water and sanitation, transportation and health care services have been created.

Urbanisation Indicators:

There are several factors and drivers which are accountable for an Urban Expansion or urbanisation. Figure 2.4 shows the levels of influences from different factors acting as Drivers of urbanisation in large extent.

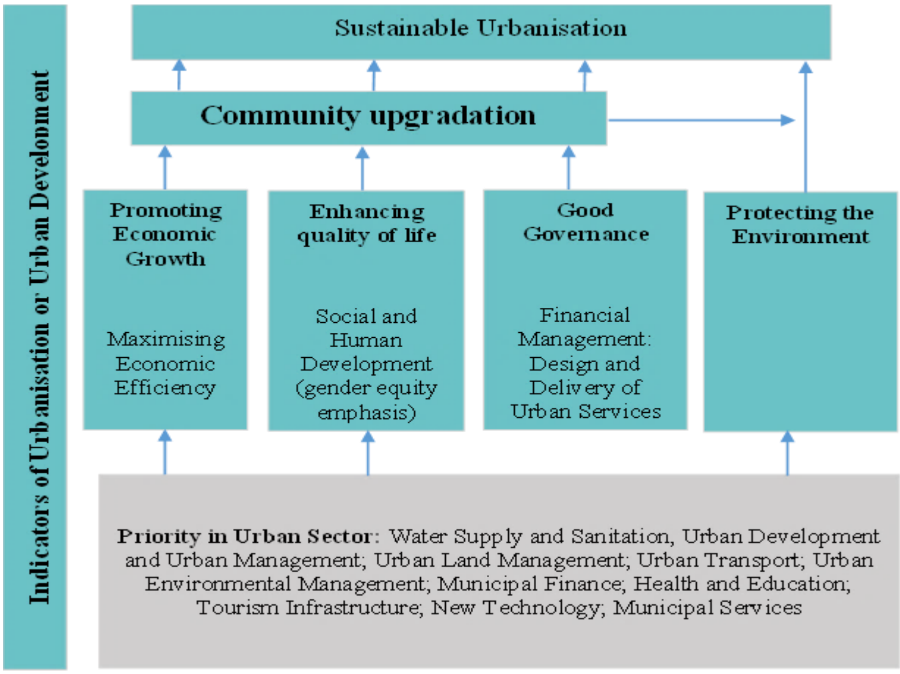


Figure 2. 4 : Urbanisation Indicators. Source: (KHITOLIYA, TANWAR, & MEHTA, 2005) (UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME, 2004) (Mavrič & Bobek, 2015) and field survey

There is a considerable literature that discusses the drivers, markets, and policies of urban development/urbanisation, as well as policies that attempt to improve the pace and shape of this process. Economic Geography, Income, Technology, as well as Market Failures and Pre-Existing Conditions, are all indicators of urban development that are structured by Policies and Regulations, which in turn shape Urban Form and Infrastructure (refer figure 2.4). Economic conditions and market functioning have always had an impact on the urban spatial expansion. The major indicators are (i) Economic Growth, (ii) Enhanced quality of life, (iii) good governance, (iv) improved environmental condition. These drivers are supported by local factors like: Water Supply and Sanitation, Urban Development and Urban Management; Urban Land Management; Urban Transport; Urban Environmental Management; Municipal Finance; Health and Education; Tourism Infrastructure; New Technology; Municipal Services.

Indicators of effective urbanisation (Fig. 2.5) should show where the city is moving in a positive or negative direction in relation to the goals. The end result is a collective index of sustainability that assigns an elaborate grade. The indicator system, like urban effective strategies, is divided into four categories: environment, social-economic, physical space, and urban planning-design. The final outcome is the collective sustainability index, which provides an overall grade.

First set: Environmental indicators

- global climate
- air quality
- rain acidity
- pollution of the eco-system
- urban mobility
- waste management
- energy consumption
- water consumption
- indicators of interference (noise, smells, etc)
- other

Second set: Social-economic indicators

- social equity
- legality
- accommodation conditions
- urban security
- economic and social balance (for example: income, age)
- citizen participation (in city management)
- other

Third set: Indicators of physical space

- the urban substance situation (age of buildings, state of preservation, facilities, etc)
- urban infrastructure (roads, sewage, water, electricity, gas, telephone ...)
- size and quality of the open area (squares, streets, embankments ...)
- green areas (size, quality and accessibility)
- equipment of centres
- distance from the centres
- other

Fourth set: The urban planning-design indicators for the city

- urban standard and pattern for reaching the human environment: taking into account size, height of a building in relation to its surroundings, proportion of mass, aesthetic dimensions,
- harmony (compatibility) of objects and places with regards to topography and between themselves,
- perception aspects of orientation (concept of streets, objects placing and relation of their masses, visual openness, views)
- accessibility, clarity of orientation and access distance in particular for pedestrian - activity, suitability of activities, variety of programs, street life and life on the square (shops, bars, walking, passageways)
- variety of urban areas, identity and individuality in the shaping of individual urban structures and places
- appearance and proportion of open spaces to built-up areas
- variety of architectural elements in the identification sense, visual and symbolic abundance (style, composition, standard)
- pedestrian areas: design and equipment (design of squares, streets, greenery, urban equipment)
- aesthetic environmental qualities: architectural character, visually pleasing details
- other

Figure 2. 5: set of Indicators. Source: (KHITOLIYA, TANWAR, & MEHTA, 2005) (UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME, 2004) (Mavrič & Bobek, 2015) and field survey

Although not precisely quantified in the literature, by altering the values of these indicators can lead to excessive unfeasible growth. The Pre-Existing Policies and Regulations or policy solution, either in the form of regulations or market-based instruments can influence factors including zoning, building codes, ordinances, and property taxes that can distort real estate markets and result in uneven settlement pattern generation.

LULC (Land use and land cover) Change: In urban areas (cities and towns), land use and land cover (LULC) refers to the utilisation of the land. Land utilisation refers to the usage of land outside of the city limits, in the hinterland of the city. For example, there are agricultural lands and unused land. There are also forests and villages. First, you should be familiar with the definition of the LULC plan as well as the LULC map. This type of plan is used to help determine where and how much future development will occur in an area. Being a Part of the comprehensive plan, it examines the interrelationships between the different local authorities. If you want to reuse or redevelop a piece of land, you need to know where it is, what it looks like now and what it will look like in the future. Map and written description of LULC areas or districts are included in LULC's plan. One way to locate existing and future LULCs is with the help of a LULC map. Locations of LULCs are shown on this map. Planned LULC decisions are guided by this document. LULC plans can be implemented in part through the use of zoning. As part of a city's Master Plan, a LULC plan helps to steer the city's future development and growth.

While rapid urbanisation has only recently become a major topic on a global scale (e.g. (Foley & al, 2005); (Seto, 2014); (Felix Creutzig & Weisz, 2019)), urbanisation, suburbanisation, and urban sprawl—i.e. urban land use change at the local and regional level—have been a source of major concern and passionate debate for quite some time due to their obvious efficacy. Whereas the unintended consequences of urbanisation have been debated in the West since the mid-twentieth century, they are now a global concern. Initially, urbanisation was blamed for endangering landscape beauty, diminishing community life, and overloading public transport and network infrastructure (Nechyba & Walsh, 2004). However, the debate has clearly broadened and intensified over the decades, now raising concerns about habitat loss and biodiversity, rising greenhouse gas emissions, and environmental justice in general, to name a few. Despite its numerous disadvantages, it would be an oversimplification to simply blame urban land use change as an environmentally harmful and generally ineffective phenomenon. On the one hand, the use of land for urban purposes invariably reduces its "value" in other (primarily environmental) ways; on the other hand, urban land use change is essentially a by-product of demographic change and economic growth, and it is difficult—but not impossible—to imagine prosperous and dynamic societal development without any kind of "land consumption"—particularly in econometric terms e.g. (Yue Ge, 2010). This same controversy over whether urban land use change is a blessing, or a curse involves not only goal prioritisation, but also a heated academic debate over the validity of countless empirical findings on its adverse repercussions. The intellectual discourse over the impact of urbanization and changes in urban land use has become almost incomprehensible. There are, however, a few major debate threads which can be recognised, each of which emphasises a specific issue of concern. Primarily, serious concerns have been raised about the ecological- environmental implications of urban land use change. Changes in urban land use increase the proportion of built-up land, such as rooftops, roads, parking lots, and pavements. Infiltration of rainwater into the ground is physiologically restricted by imperviousness. Rainfall and snowmelt that cannot be absorbed must become part of the hydrological cycle (Alberti, 1999). Thus, in heavily populated regions, soil sealing is widely regarded as a major cause of flood hazards (Frenkel, 2004). Because urban runoff water contains harmful toxins, imperviousness contributes to the biochemical degradation of water resources (e.g., from automobile traffic or industrial land uses). Moreover, the spatial density of artificial land cover with specific thermophysical behaviour causes local temperature anomalies. As a result, the densely populated urban fabric has a higher average temperature than the urban fringe ("urban heat island") (Alexander Buyantuyev, 2009); (Watkins, Palmer, & Kolokotroni, 13

March 2007). Furthermore, to the amplitude of urban land use change, the spatial structure must be considered. Scattered and segmented land use patterns are a major contributor to landscape fragmentation, which is distinguished by the punctures, discectomy, and separation of habitat environment and the natural or semi-natural ecosystems. (A.G.Jaegerad, 2008). The environmental "quality" of the resulting land use patterns calculates the net effect of urban land use change. Indeed, the characteristics of land that became urbanised within a specific time period (e.g., soil quality, habitat quality, vegetation, etc.) must be examined from an economic perspective. The loss of prime agricultural land, which is crucial to agriculture's long-term competitiveness and sustainability, is one particular source of concern (David L.Tulloch, 2008). Livestock and crop production on remaining farmland can also be hampered by urban development in increasingly fragmented agroecosystems. The (non-monetary) costs of providing public services to settlements have been commonly mentioned in urban sprawl research that focuses on the economic effects of urban land use change. In 1974, the “costs of suburban development” study (Real Estate Research Corporation) presented empirical evidence for a negative relationship among residential development density and the fiscal costs of providing basic urban services. The outcomes of research sparked a heated debate, not only about the implications for urban development policies, but also about methodological uncertainties. Several subsequent studies confirmed the 1974 work's findings (see (Robert W Burchell, 1998-1999) for a comprehensive list of references); others questioned the effect of urban form factors on infrastructure costs. Finally, authors presently tend to agree that low-density and diffused urban development patterns are more expensive than more compact development patterns. Unintended social consequences of urban land use change have also been chastised, particularly in relation to the broad process of suburbanisation that has afflicted cities and urban agglomerations worldwide for decades (Rob Gray, 2003). Beginning in the 1960s, the “spatial mismatch” debate focused on the extent to which minority populations' residential options were constrained, in tandem with intra-regional decentralisation of employment. Last but not least, the effects of changes in urban land use on motor driven traffic volume is likely the most frequently debated subject in this course of research. Studies that monitored for population, social economic, and behavioural factors (such as family income, number of dependents, or age) concluded that urban form has a significant impact on mass transit.

2.1.3 Urban Sprawl and Peri-urban

Urban Sprawl:

In India, urban areas are broadly classified into two types, as shown below:

i) *Definition by state government:* By public notification, the governor of the state declares an area “urban” based on certain parameters such as population growth, population density, local authority revenue earning capacity, urban worker percentage, economic upgradation, or similar ones.

ii) “National government (census office) definition:

(a) All administrative units established by statute (i.e., settlements declared based on state government definition).

(b) Administrative units that meet the three criteria listed below:

(i) minimum population of 5,000 people;

(ii) 75 percent or more of the male main working population engaged in non–agricultural pursuits; and

(iii) a population density of at least 400 people per square km (1,000 per sq. mile)."

Rising urban population and rapid urbanization are unintended consequences of India's unprecedented population increase and population movement. Cities are increasing as a result of a transition in land use near highways and in the direct proximity of cities. The term "sprawl" relates to scattered growth beyond the compact city and countryside centres, along highways, and in rural countryside (David M. Theobald, 2005). Urbanisation, a type of metropolitan growth, is a reaction to complex economic, social, and political influences, as well as a region's perplexing physical topography. These include things like population growth and the economy. Government-funded infrastructure programmes, such as road construction, are also variables. Such urban sprawl has a serious influence on the land use and land cover of the geographical area.

Sprawl can happen as a consequence of a variety of development types, including agricultural land, open space, and ecologically sensitive ecosystems. It is common to conflate sprawl with the growth of a town or city (radial spread). Sprawl is characterised as the expansion of a city's periphery as a result of rapid population growth. In general, sprawl occurs near the metro's outskirts or along highways.

Rural areas are indeed being converted into towns, towns into cities, and cities into metropolises. To make preparations for such an ecologically feasible development, a solid understanding of growth dynamics is needed. Notwithstanding, there are numerous weaknesses in order to determine the nature of unrestrained urban sprawl. Sprawl is outlined as the unforeseen growth in urban centres all along outskirts of urban, parallel to the longitudinal highways, all along route connecting a city, and on and on. Due to a major lack of relevant planning, these outward manifestations lack the basic access to water, power, sanitation etc. The provision of specialised infrastructure facilities, such as new roads and highways, facilitates such sprawls. The correlation between mass transit infrastructure building cycles and bursts in urban development has been re-examined, according to (LindaBerryEricHirst, December 1990).

Cities are projected to grow at a lesser rate than their populaces. Such reforms are likely to have both local and off-site environmental implications, such as exacerbating quality of water and a higher likelihood of malady trajectories being fostered. (Thomas J. Douglas, 13 Dec 2017)

Table 2. 1: Factors causing Urban Sprawl, Reference EEA,2006

Macro - Economic factors	Economic growth
	Globalisation
Micro - Economic factors	Rising living Standards
	Price of land
	Availability of cheap agricultural land
	Competition between municipalities
Demographic Factors	Population growth
	Increase in household formation
Housing preferences	More space per person
	Housing preferences
Inner City Problem	Poor air quality
	Noise
	Small Apartments
	Unsafe Environments
	Social Problems
	Lack of green open space
	Poor quality of school
Ease of Transportation	Private car ownership
	Availability easy transportation routes
	Low cost of fuel
	Poor public transport
Regulatory framework	Weak land-use planning
	Poor enforcement of existing plans
	Lack of planning management system
Source: Prepared by author	

Peri-urban: The theory or topic of peri-urban emerged from the west and subsequently followed the east in the globe from era as early as 1800. Different field expertise was involved based on derivation of theories, models, empirical formulas, field research etc. But the complexity and irregularity of languages developed in these peri-urban shadow zones that the analysis and solutions were never part of the same page of the same book.

Burgess advocated a city growth model based on a succession of circular zones—from valuable land in the centre, through the transition zone, working class dwellings, and nicer residences, to the commuter zone—where the city would spread radially as early as 1928. In the late 1930s, Hoyt amended this, claiming that expansion occurred in evenly pie-shaped sectors that spread radially from the city's centre to its periphery, rather than through rings of growth.

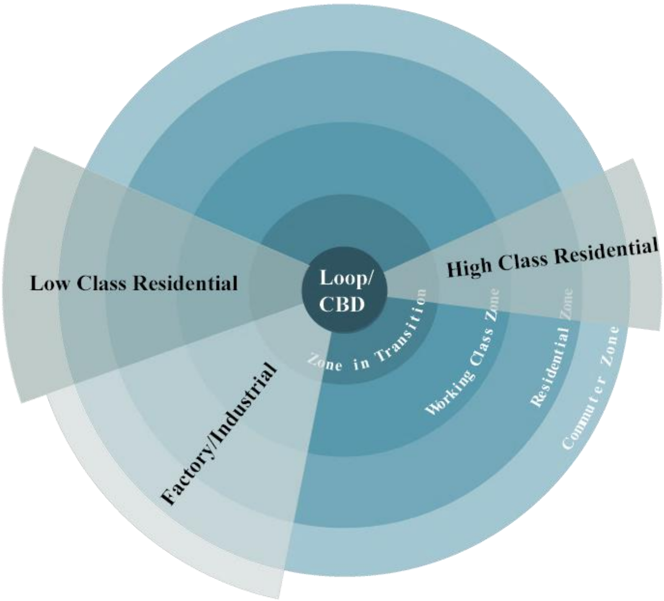


Figure 2. 6 : The concentric ring theory from the Chicago School.

The authors of the LA School argue for polynucleation, in which cities expand from the merging of multiple minor towns or nuclei, particularly at their peripheries, rather than from a single CBD.

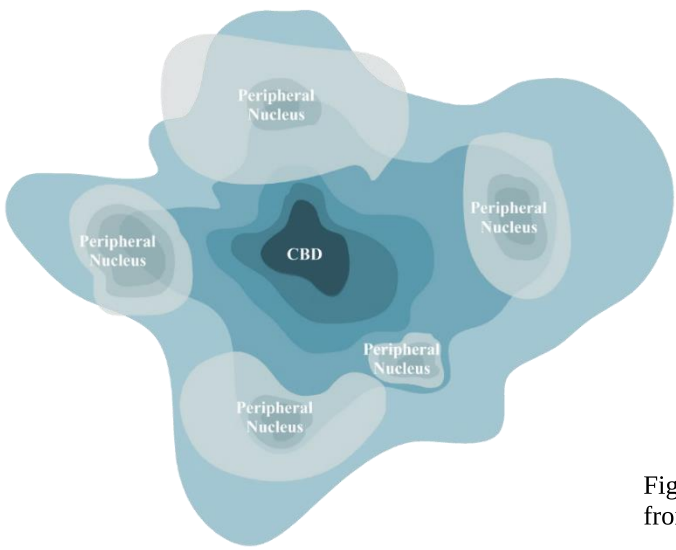


Figure 2. 7 Poly-nucleated metropolis -theory from LA school

"The extended metropolis-settlement transition in Asia" by (McGee, 1991) re-examines the conventional definition of urban transition in the context of a larger paradigm shift in countries' space-economy, which is quite important in the Asian context.

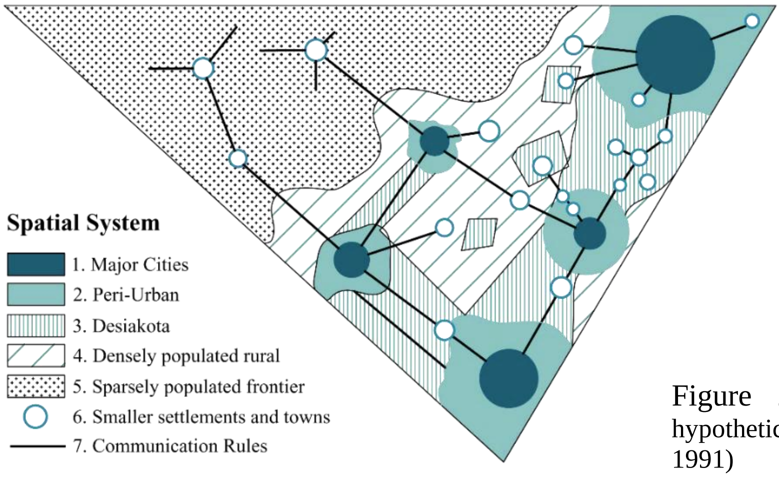


Figure 2. 8 Spatial Configuration of a hypothetical Asian Country. Source: (McGee, 1991)

Following are five major regions of the space economy that are defined by McGee in his Asian country spatial configuration model: For example, major cities in Asia are dominated by one or two megacities. Peripheral urbanisation refers to the areas surrounding major cities that are easily accessible by public transportation on a regular basis. As derived from Indonesian, the term Desakotsi refers to densely populated agricultural areas that often stretch along corridors between large urban centres and are characterised by dense populations engaged in agricultural activities. rural areas with a high population density. borderlands with few people. It is defined as "the areas surrounding cities within daily commuting distance of the city core" by McGee. A city's core can be up to thirty kilometres away in some parts of Asia (1991, p. 6-7). As a result of the historical evolution of high-density and rice-growing areas, McGee believes that at least three types of spatial economy transition are occurring in Asia:

- *Desakota* Type1 – A decline in rural settlement and land use has occurred in these areas, and the agricultural population has migrated to urban centres. Like South Korea and Japan, where most of the economically active work is not agriculture-based.
- *Desakota* Type 2 – These are locales where agricultural and industrial productivity improvements, as well as population shifts from agricultural to non-agricultural, have centered on the core city and surrounding regions over time. In comparison to the rest of the country, these are also locations with strong economic growth.
- *Desakota* Type 3 – These are high-density areas with slow economic growth and a high level of involuntary economic activity. These areas are typically found along secondary urban centres.

To elaborate on this concept further, (Jeremy Rowan-Robinson, 1995) referred to the growth of mega-cities and the emerging spatial patterns in ASEAN mega-urban regions as decentralisation and dispersal. Many people believe that decentralisation and dispersion are efficient ways to mitigate or reduce the extreme negative effects of these quickly expanding metropolises. People and economic activity are shifted from urban centers to peripheral communities and along main transportation corridors spreading from the urban core to the metropolitan region, which is known as decentralization. When people and activity leave secondary or provincial cities or other growth centers, they spread. This decentralisation has been attributed to market forces as opposed to government policy. The majority of Asia's megacities have adopted spatial planning strategies that aim to develop a decentralised form in their metropolitan regions, recognising the advantages of polycentricity in their metropolitan regions. These are usually incorporated into the master plans of these authorities. A number of Asian mega-cities were examined by (Jeremy Rowan-Robinson, 1995), including Calcutta, Delhi and Bombay, Dhaka, Seoul and Bangkok. A significant amount of decentralisation has taken place in Asian megacities, according to the report. While the urban area/built-up has grown tremendously, most of the decentralisation has taken place along major transportation corridors leading out of the core city.

In the ODA Renewable Natural Resources Research Strategy (1999, p. 5) the peri-urban interface is defined by strong urban influences, easy access to markets, services, and other inputs, ready supplies of labour, but relative shortages of land and risks from pollution and urban growth. He referred to the rural-urban fringe as the "ultimate battleground" of environmental and socioeconomic change brought about by urbanisation. Rural-urban fringe is ignored as a specific area within urbanisation studies. The rural-urban fringe stretches from the city's contiguous built-up region (no rural land-use) to the area where the bulk of employees are employed in non-agricultural occupations in most villages/towns (many of whom commute) (Bentinck, 2000).

(Iaquinta & Drescher, 2001) stated that 'proximity to the city' is not a fundamental feature of the definition of peri-urban. It's merely coincidental to a basic knowledge of peri-urban. The focus on a single physical place as the basis for defining peri-urban misses the point of seeing the rural-urban spectrum as dynamic, interactive, and transformative. As a result, peri-urban is definitely more than just a sliver of the city.) Urbanisation, according to (Iaquinta & Drescher, 2001), , is a process of human life and activity being concentrated and intensified. Fertility, death, and migration are three essential population processes that occur in a physical environment, resulting in an uneven process. Such processes are the result of individual and household decisions made in a sociocultural, economic, political, and environmental setting. Village Peri-urban, Diffuse Peri-urban, Chain Peri-urban, In-place Peri-urban, Absorbed Peri-urban, and the five elements nested within the greater rural-urban dynamic make up Iaquinta and Drescher's peri-urban typology. The typology is based on underlying socio-demographic processes, particularly migration, which organize transformational relationships along migration and time dimensions. Organic two-way exchange networks connect the typology, which can be summarized as follows:

A summary of various typologies (Iaquinta & Drescher, 2001)

- Village Peri-urban: These areas are geographically non-proximate to an urban area yet have an urban consciousness. Its status as a peri-urban area is based on its social psychological alteration rather than its size or location.
- Diffuse Peri-urban: A subcategory of peri-urban that includes areas near the city that are settled based on migration. The immigrants are from a variety of geographical roots.

- Chain Peri-Urban: Geographically close to the city, this is an urban fringe that is being established through a chain migration process. Areas identified as 'squatter settlements' around metropolitan regions are mostly of this type.
- In-Place Peri-urban: Geographically close to the city, caused by in-place (in situ) urbanisation, natural growth, and some migration. These are areas that are being completely absorbed by actual urban fringe expansion or simple reclassification.
- Absorbed Peri-urban: These are areas close to or within the city that have been absorbed for a long time. These areas are derived from either in-place or chain peri-urban areas.

They suggest that rural migrants first settle in villages or small towns before moving to larger cities, demonstrating the dynamic nature of the peri-urban environment. There are two sorts of linkages created by changes in space and time. Diffuse Peri-urban and Chain Peri-urban are the two types of peri-urban that most closely resemble geographers' or urbanists' definitions of the 'urban periphery.' In-place peri-urban shares some characteristics with the fringe, although it is more strongly associated with the Desakota type. Furthermore, the concept of village peri-urban has nothing to do with urban edge. The city of Kolkata is undergoing considerable peri-urbanisation of the Diffuse, Chain, and Absorbent types. The boundary of which is still hazy and volatile, and cannot be calculated using any formula, but can be linked to the moss's diverse growth.

2.1.4 Urban Governance, Planning Guidelines and policies

Urban Governance:

The method by which governments (local, regional, and national) and stakeholders decide how to plan, finance, and manage urban areas is regarded to as urban governance. It entails an ongoing process of negotiation and contestation over the distribution of social and material resources, as well as political power. As a result, it is intensely political, affected by the formation and management of democratic structures, the potential of the government to create and achieve objectives, and the extensiveness to which these choices identify and respond to the need of the poor and marginalized. It comprises a large variety of economic & social forces, organisations, and connections. Job markets, products and services; residential, members of the family, and social connections; and vital infrastructure, land, services, and public safety are instances of these (Devas, et al., 2004). There often seems to be huge variations between poor and better-off urban dwellers in order to have access to social, economic, and political advantages (especially judgement call) as well as the right to interact in and maximize the value of urban living. (Slack & Côté, 2014)) identify urban governance as:

- plays a key role in influencing the physical and social character of urban regions;
- influences the quantity and the quality of community resources, along with their effectiveness of delivery;
- calculates cost sharing and resource allocation among different groups;

- and impacts residents' permission to connect local government and partake in decision-making, affecting local government transparency and efficiency to citizen expectations.

Variety of actors and institutions are entailed by urban governance, and the interactions between them determine what happens in the city. Government (at all levels) must play a pivotal role in forging partnerships with and among key stakeholders in order to manage urban metamorphosis (UNESCAP & UN-Habitat, 2010).

Whereas the city government is the largest and most visible urban governance actor, most of what tends to affect the life prospects of the underprivileged is really beyond city administrations' regulation. Rather, the daily perspectives of urban residents are determined by market forces and private corporations, central state departments, or collaborative voluntary action of civilized society.

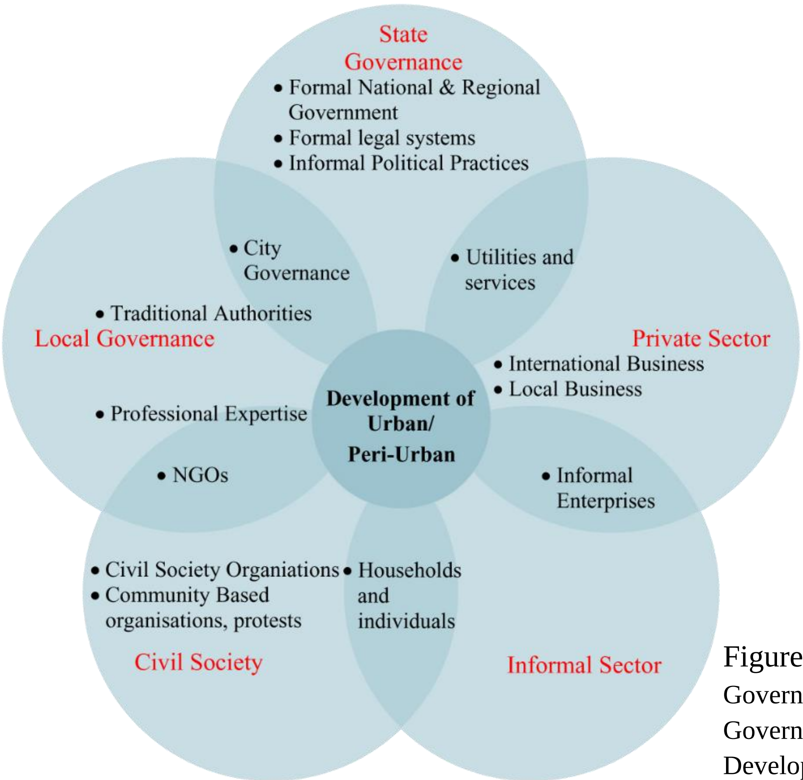


Figure 2.9 Actors and Institutions of Urban Governance(Derived from: (Devas, Urban Governance, Voice and Poverty in the Developing World. , 2014), (UNH, 2009)

Good Governance:

The potential of government entities to just provide public goods effectively, to foster an environment conducive to job creation and growth, to resolve market failures, and to raise public awareness in the methodology is more important than ever. Countries with strong organisations are more adaptable, resourceful & better able to cultivate development of the private sector, eliminate inequality, offer additional important services, and receive peoples' confidence. The World Bank identified Good Governance in its 1992 report titled "Governance and Development." World Band describes Good Governance as "the exercise of power in the management of a country's economic and social resources for development". There are eight major components of good governance. "**It is participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive and follows the rule of law.**"

- It guarantees that corruption is mitigated, minority communities' viewpoints are factored into the equation, and the perspectives of humanity's most susceptible are listened in judgement call.
- It also caters to the current and future requirements of society.

Strengthened institutions and improved governance are especially critical for the most vulnerable area lies in mode of transition.

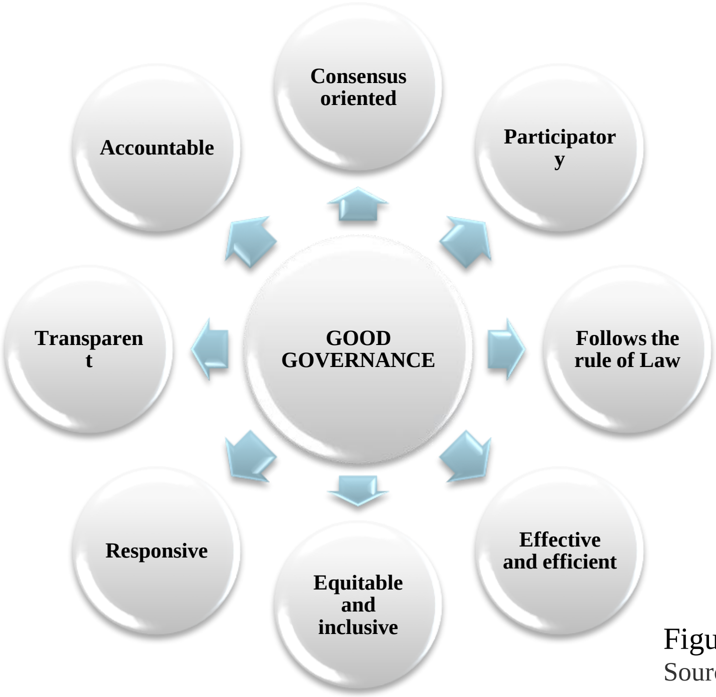


Figure 2.10: Principle of Good Governance
Source: Prepared by author

The Key points to be discussed about forming the base of good governance (Fig. 2.10):

a) **Revenue Utilization:** Financial sustainability is a significant development priority that is required to finance investment opportunities in fundamental services such as hospitals, education, hygiene, community security, and public transit in order to accomplish the World Bank's twin goals of eradicating poverty and intensifying economic stability. A comprehensive extrapolation and grass-roots comprehension will support in the linear progressions of the fringe's infrastructure improvements.

b) **Direct democratic planning:** People should be allowed to represent themselves via legitimate direct institutions or legislators. Males and females, susceptible segments of community, weaker sections, minority communities, and so forth are included in. Involvement involves the liberty to correlate and express ideas.

c) **Anticorruption, Openness and Transparency.**

d) **Public Organisations:** Economic structures determine whether people invest, save, empower themselves, and actively sought out and incorporate new products. The structure, purpose, and performance of economic institutions are ascertained by democratic structures. Underperforming government agencies demonstrate low management and supervisory capabilities, reduced performance, a lack of transparency, lack of compliance, and malfeasance. Financial institution aid to public institutions is focused primarily on basic functions such as policy, planning and decision - making process, management of human resources, tracking, and assessment. Financial institution assistance for structural reform is increasingly primarily directed at dealing with the underlying politics and economics forces that influenced rewards, how organisations are established, how they communicate, and how they operate. This is achieved by analysing power dynamics, responsibility, supervision, and public participation.

e) **Governance Probity:** Governance probity is the quality of having strong moral principles. It involves possessing moral fortitude, righteousness, and sincerity. It encompasses being not only uncompromised and truthful, but also ensuring adherence to a code of conduct. Probity is critical to a successful system of governance and improvement of living standards. The epistemological fundamentals of governance and probity:

• These same ethical implications of democratic accountability have been conveyed both in Asian and European literary works, such as with the Bhagavad Gita, Arthashastra, Confucius, Plato, Mill, and others.

• Administrators are indeed the custodians of the Federal Bureaucracy, and they should preserve the trust of the public.

• Max Weber asserted that it is rational for governmental members of staff not to own productive resources.

Objective of probity in governance:

• To ensure transparency in governance;

• To maintain moral fortitude in public service;

• To make sure effectiveness of internal controls;

• To maintain basic faith in government processes; and

• To eliminate the possibility of misbehaviour, fraud, and corruption.

f) Good Governance Index:

The Minister of State for Prime Minister's Office; Personnel, Public Grievances and Pensions, Dr. Jitendra Singh launched the 'Good Governance Index' (GGI) at an event organized by the Ministry of Personnel, Public Grievances & Pensions, on the occasion of Good Governance Day (Dec 25)

i) The Good Governance Index (Fig. 2.11) is a standardised tool used throughout nations to examine the situation of governance and the influence of external interventions implemented by state and local governments and union territories.

ii) The Good Governance Index's purposes are to provide quantitative data to compare the state of governance throughout all states / Union Territories, to facilitate states and Union Territories to design and execute suitable recommendations for enhancing governance, and to switch to result-oriented initiatives and management.

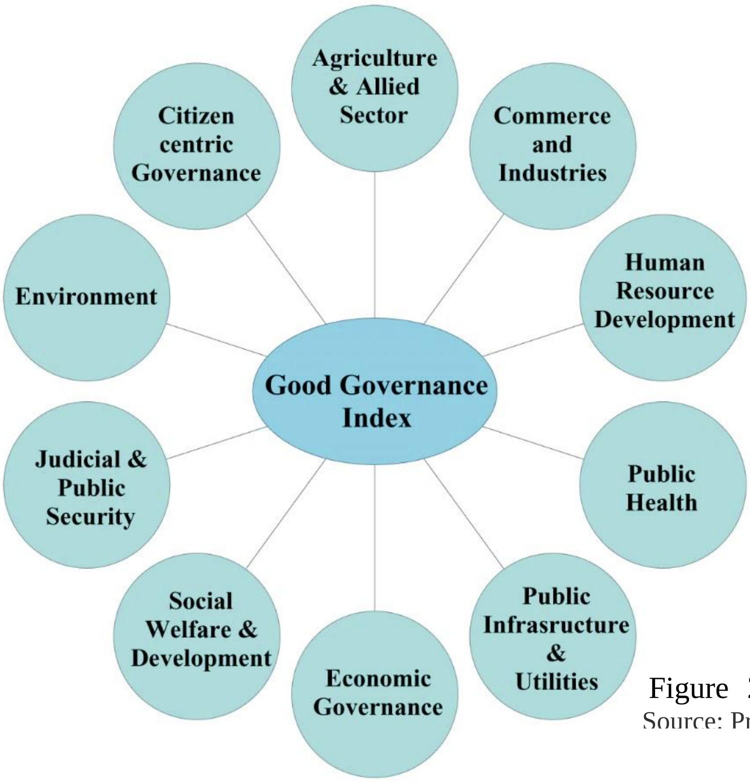


Figure 2.10 : Index of Good Governance
Source: Prepared by author

This Thesis deals with following indicators related to urban physical planning issues and affordable housing for all under social welfare development.

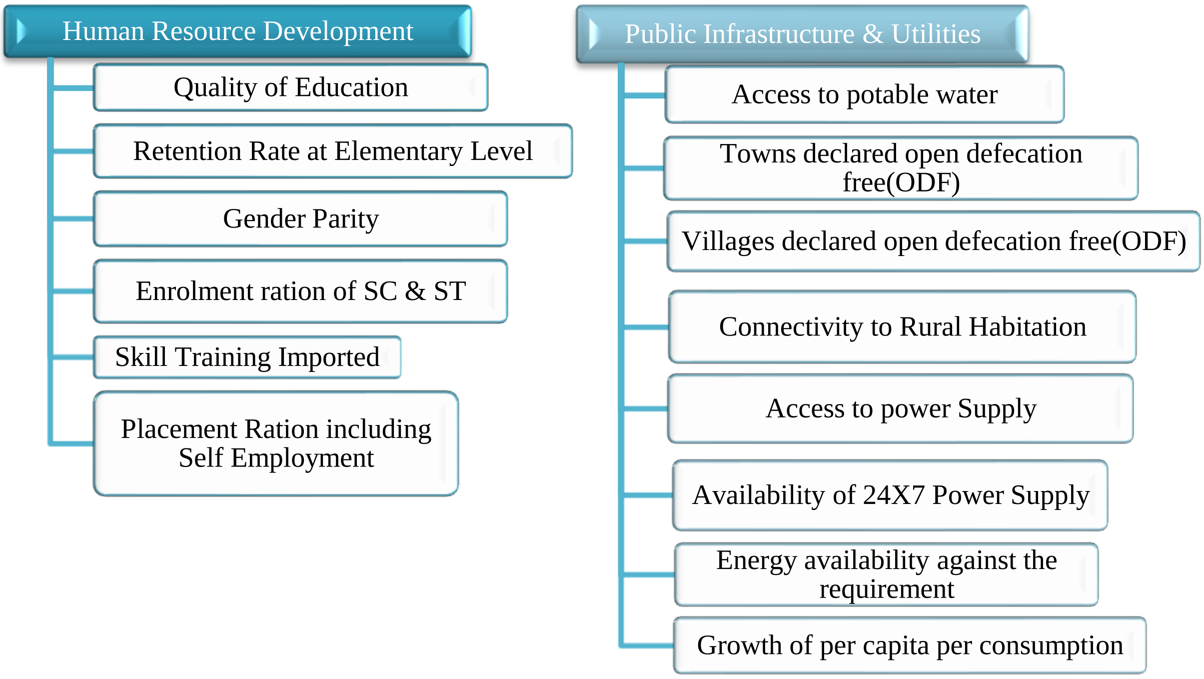


Figure 2. 11 : Factors of good governance
Source: Prepared by author

Planning guidelines and policies: A policy is a course of selection techniques among the numerous options by an individual or an organisation that affects ongoing and prospective strategic planning. The planning process is the most appropriate method for constructing, incorporating, and assessing policy ideas. It is traditionally divided into 6 stages: action configuration, policy development, adaptation, execution, assessment, and policy preservation. It is regarded as a loop (fig. 2.13) so because consequence of the policy's deployment will support in establishing any changes to the current guidelines or the establishment of a new one.

The procedure is explanatory, that is, it's indeed simply a given way of monitoring policy decisions, but still, it runs into difficulties as it is too easy and straightforward for a confusing environment. It would seem to be a repetitive model with a commencement where lawmakers recognise a matter and a finish for which they evaluate how fruitful the execution and its influence have all been in fixing the dispute; even so, planning process could also begin, be modified, or be disposed at either of these stages. Moreover, millions and millions of policy loops communicate in the policy - making system, raising its complex nature and uncertainty.

The Planning Commission was a Government of India institution that developed India's Five-Year Plans before being replaced by the NITI Aayog. The legislature then approved these plans. However, as time passed, more power shifted into the hands of the executive. Aside from that, India has adopted a parliamentary form of democracy as well as a quasi-federal governance structure, which means that various levels of hierarchy must be considered before setting objectives. Such fragmentation fails to recognise that actions taken in one sector have serious consequences in another and may conflict with the policies of the other. Furthermore, even for closely related sectors, aligning their policies in accordance with a common overall agenda becomes extremely difficult.

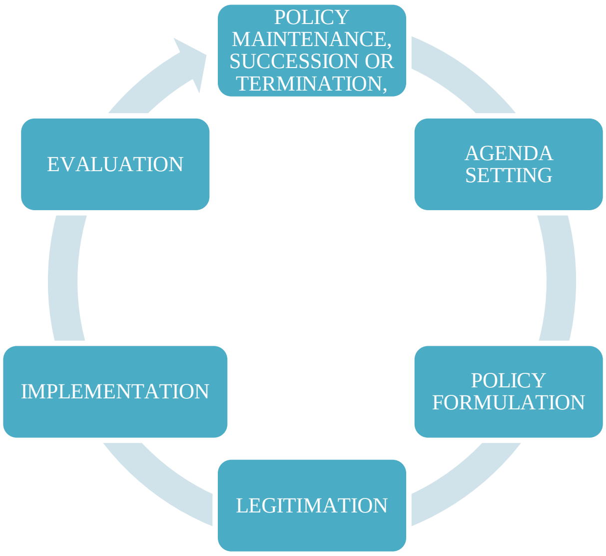


Figure 2. 12 :Image
Source: https://paulcairney.files.wordpress.com/2013/11/cycle.jpg

2.1.5 Globalisation and its effect on peri-urban

Globalization's effects on cities are complicated, multidimensional, and geographically dispersed. The transformation to a market economy, opening up to the outside invested capital, and successive acceleration of economic reform compelled the massive development of urban spatial economic systems in the twentieth century. McGee and Watters have identified two aspects of today's globalisation–

- greater integration of national economies with global production, consumption, and distribution systems
- the effect of technological advances in transportation, communication, and computer technology on space-time contraction.

And, because cities are the primary spatial framework within which capital, goods, people, and information are concentrated, globalisation has had an impact on urban space formation in India. Globalisation is one of the most widely discussed themes in the world, covering a wide range of topics such as economics, politics, religion, and social issues. Globalisation has had such a big impact on economic and social factors that experts such as (Brenner, 1999) and (B Birrell, 1997) consider it as a worldwide phenomenon, as the name implies. Globalisation, according to (Amin, 1998), is not confined to the movement of tangible items such as products and people, but can also encompass intangible items such as ideas. As a result, globalisation can now be defined as the greater flow of lifestyles, policies, beliefs, philosophies, commodities, and people across international borders. Globalisation has a stronger impact because it has influenced many areas, the majority of which are social in character, such as lifestyles, culture, and images, according to this definition. It's also worth noting that two primary elements have fuelled the expansion of globalisation: technology and media advancements. On an almost annual basis, a slew of new and innovative technologies are developed, all of which have an impact on how people communicate and exchange ideas (Taşan-Kok & Weesep, 2007). Furthermore, the expansion and development of social media channels now play a key part in people's lives by causing considerable changes in people's likes and preferences. Regardless of the roots of globalisation, many theories contend that it will have a substantial impact on society. Globalisation, for example, has a substantial impact on social characteristics, values, norms, and beliefs, as well as actions and processes that contribute in the identification of people's personalities (Ritzer, 2003). In this sense, it is important to remember that globalisation has an impact on how individuals live. According to the conclusions of a study done by (Jessop & Sum, 2000), there has been a substantial shift in the way people live as a result of globalisation, particularly in cities. This notion illustrates that, in terms of structure, style, design, or development, there is a significant link between globalisation trends and cities. Because of changes in lifestyles, society, interests, and preferences, this is the case (Johnston & Laxer, 2003). As a result of globalisation, cities are being redesigned and developed in new ways. This idea is simple to describe and can be applied to cities in the process of being developed. As a result, people's attitudes regarding current western architectural building designs, as well as their desire to live in cities, are likely to change. Furthermore, a shift in the way cities are administered has been noted as a result of the flood of new ideas brought about by globalisation. With all of these factors in mind, it's clear that more research into the consequences of globalisation on cities is required. However, the extent to which globalisation affects local urban systems and local development varies depending on how and where it is approached. This implies that globalisation has different global effects depending upon how local environment or people respond to globalisation and in turn influences urban systems and local developments. As a result, the higher the local population's reaction to globalisation, the greater the degree of change in terms of urban systems and local development. As a result, the following questions can arise;

• What exactly is globalisation, and how does it impact urban development?
• What are the effects of local and global forces on urban change?
• To what extent do global processes influence peri-urban development?
• Why are peri-urban or regional systems still reliant on cities when globalisation can make them less reliant?
• How do changes in global capital flows affect the real estate and property sectors, causing changes in different sectors from urban to rural area?
• How can urban management be modelled to account for or accommodate urban globalisation?

The above questions can be grouped into four elements and the obtained elements are illustrated in a diagrammatical form as shown in figure 2.14. It can be noted that the effects of globalisation will initially commence on a global scale then extend to the lower level. Changes which global and local aspects of globalisation recognise are from the urban systems rising to affect peri-urban areas of cities. It is at the peri-urban level that we find property market dynamics.

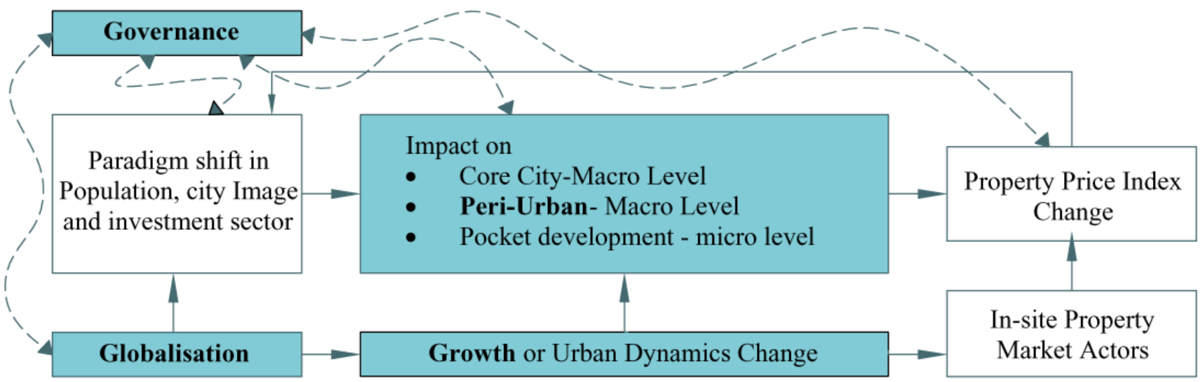


Figure 2. 13 : chain reaction of 3Gs involved in peri-urbanisation
Source: Prepared by Author

The graph above portrays globalisation as a multifaceted factor that influences a number of aspects. As aforementioned, it affects the mobility and circulation of capital, images, products, and people, culminating in urban change as it begins to reflect in micro-urban and macro-urban change, ushering growth. As a result of globalisation, there are also changes in governance. Once governmental structures begin to shift, macro and micro-urban changes, as well as changes in property market dynamics, are unavoidable. Changes in property market dynamics typically result in a shift in property market actors' reactions. There are ideas, however, that contradict some of the implications made by figure 2.14, and such ideas agree that globalisation affects a wide range of spatial, economic, and social patterns, but they disagree on the idea that globalisation results in the same spatial patterns. Attempts to investigate how globalisation affects peri-urbanisation can also be examined using the interaction of local and global growth dynamics, as illustrated in next figure.

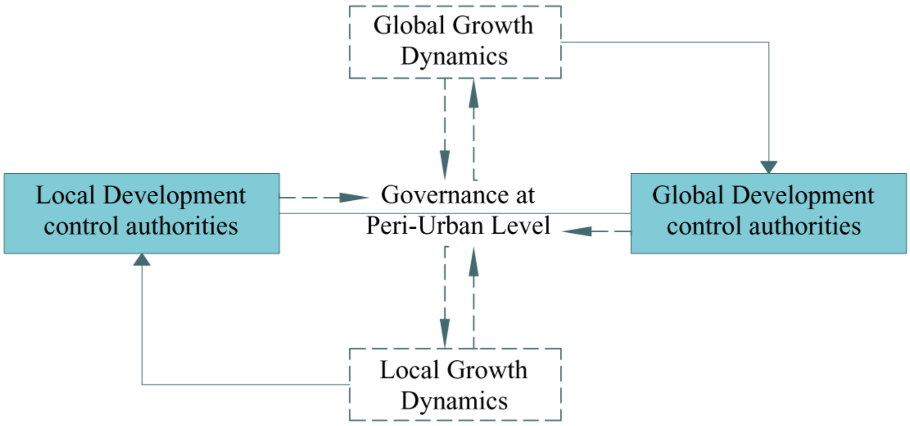


Figure 2. 14 : Dynamics of 3Gs at peri-urban level peri-urbanisation
Source: Prepared by Author

Figure 2.15 depicts how local and global dynamics interact to influence changes in local institutions. The same is accurate for local and global organisations; they all have an impact on the local organisations, and it is through changes in local organisations that changes in cities and its peri-urban can begin.

What is being globalised?

Different perspectives on what is being globalised can also be expressed. According to some studies, globalisation does not globalise anything (Jessop & Sum, 2000); (Johnston & Laxer, 2003). On the other hand, it should be noted that globalisation has an impact on almost everything, whether it is retailing or consumption (Jessop B. , 2000). This is supported by (Ritzer, 2003) ideas, which purport that globalisation has occurred in almost identical patterns of consumption, as well as an increase in the creation of non-places. As a result, the number of entertainment centres, office parks, and shopping centres is expanding. The ability of people in other cities to follow the same patterns, on the other hand, does not imply that a standard measurement or idea as effect of globalisation is the same but rather serves as an inspiration for spatial development. Though cities may adopt the same architectural style, design, scale and function, the fact remains that globalisation does not have the same effect all over the world or on cities (Johnston & Laxer, 2003).

Urban/Peri-urban change: Global and Local Forces

Global forces tend to have an impact on urban areas and such impacts are due to the following reasons;

- Economic globalisation causes cities to use state of the art finish materials for structures as capital funds are moved from one nation to the other especially from advanced cities to urban areas that may possibly be lacking in terms of development (Ritzer, 2003).
- Increased global competitiveness prompts cities to seek new regulatory frameworks to support non-market, neoliberal, and entrepreneurial market regimes (Taşan-Kok & Weesep, 2007).
- Cities are a type of legal system, and their administrators tend to adopt social, political, economic, and local conditions. This is due to the fact that urban development tends to assume certain patterns, making it difficult to develop a model of a globalised city (Taşan-Kok & Weesep, 2007).
- Cities are competing fiercely for international funds and efforts to attract more funds than others will be reflected in positioning developmental activities in order to gain a competitive advantage over other cities (Jessop, 1998). However, globalisation is said to increase the subjugation of localities (cities or regions) to global forces (Amin, 1998).

Globalisation and property markets in peri-urban:

Globalisation brings a distinct effect on property prices in peri-urban areas. Ritzer (2003) argues that globalised cities have characteristics such as financial centres that bear on the urban economy. Removal of barriers to capital movement results in new urban areas that become places for producing, working, residing, consuming and servicing. Real estate investors, especially from foreign shores with globalised character, find these lucrative to develop because of their inherent mixed-use character. This is turn spreads the features of a globalised world with new standards and attracts further financing.

Fringe areas of the metropolitan cities have become the most crucial sites of India's hi-tech services-driven new urban economy—as well as its complexities and contradictions. With global investments pouring in, new age smart cities, ultra-modern apartments and gleaming software technology parks have started sprouting up in the areas, once considered as rural outskirts of the big cities. But, conversion of agricultural lands has become controversial over livelihood vulnerabilities of the rural communities. Regional- and state-level political actors have a crucial arbitrating role at this point of interface between the local and global forces.

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2.1.6 Impact of unforeseen circumstances on peri-urban

As per (Daniels, 1999), there seem to be eight factors that have become barriers in developing and controlling expansion in urban periphery, notably:

i) interleaved and segmented government, authority, and special areas of expertise.

ii) The periphery areas are vast.

iii) A lack of foresight at the municipal, county, or regional scale.

iv) A lack of comprehension with one's own individuality as well as position in the world.

v) Migrant workers, social tension, and population increase are all factors to take into account.

vi) There's also a lot of new growth, but it's inconsistent.

vii) Inadequate assets in the field of urban planning.

viii) Outmoded physical persistence of designation and planning approaches.

Whereas the strategy for challenges in the rural-urban nexus is growth management and legitimate approaches. The succeeding clustering method is proposed:

1. "The Pro Growth Strategy": The transition of outlying villages to a more metropolitan way of life. Indeed, the periphery serves as a kind of land bank for urban development.

2. "*The Balanced Growth Strategy":* The said approach encompasses some earlier populated areas for growth/development whilst also safeguarding others. The choice is not between growth and environmental protection, but also how to manage growth so that the environment remains more attractive and has financial benefit**.**

3. "***The No Growth or Very Slow Growth Strategy":*** This technique entailed forming a barrier around the community, making change and progress difficult and costly.

From the three strategies, this study chosen the concept of "The Balanced Growth Strategy" is intended as the growth management so that the environment continues to be attractive and have the economic value.

2.1.7 Transportation Network and urban sprawl generation.

The formation of linkages through transportation corridors is the primary cause of urban sprawl. The construction of a transportation link connecting the 2nd degree CBD resulted in the exaggeration of housing blocks maintained by the growth of income for the middle-class population. This condition caused a part of the urban population to relocate to the city's periphery, a procedure (Fig:2.16) which is exacerbated by the slapdash construction of individual houses. Higher intervals between residential neighbourhoods and places of employment or education have been the main factors of enhanced personal transportation. In this particular instance, Kolkata is experiencing an unprecedented urban sprawl in the form of peri-urbanisation.

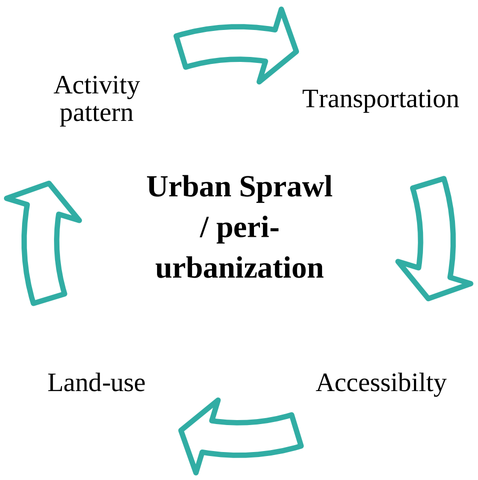


Figure 2. 15 : Interconnectivity between various factors resulting urban-sprawl
Source: prepared by the author

This same position of operations and their need for communication stimulates transportation demand, whilst also transport modes influence the location itself. This is a never-ending loop that progressively broadens the urban environment. The public transit interplay is represented in the Fig. 2.17. Variables affecting the transportation-land-use correlation involve:

1. Growth of urban land
2. Ownership of private automobiles tends to dominate
3. This same perspective wherein land use and mass transit decisions are taken
4. Varying time circumstances for response.

The mobility of people and goods in a city, termed to here as flow of traffic, is the cumulative effect of land activity as well as the capacity of the transport network to manage this flow of traffic, precisely like the demand and supply principle. There is indeed a direct relationship between the type and intensity of land use and the transportation facilities available. The main consideration of urban planning would be to ensure an efficient balance among land use operation and mass transit potential. Land use is a key indicator of movement patterns, i.e. trip generation, which necessarily involves the use of roads and transport networks. This will result in higher ease of access, which will significantly raise the value of the land and land use.

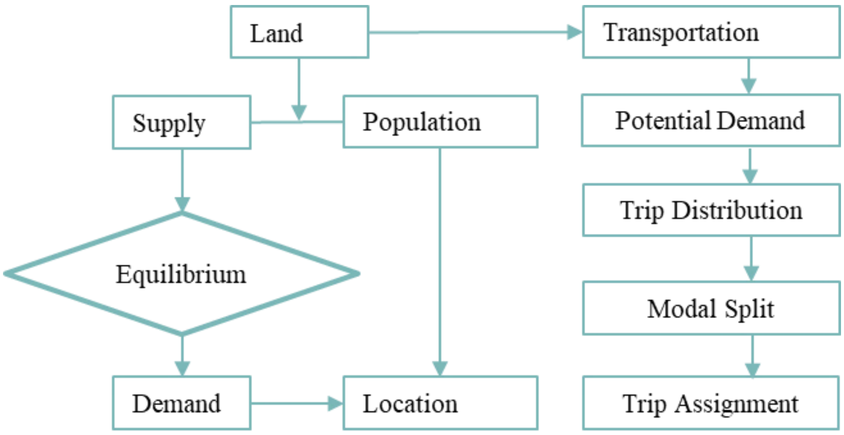


Figure 2. 16 : Land dynamics in relationship with trip generation
Source: prepared by the author

Following are few important LU transportation Moel:

The Density Saturation Gradient Method (Hamberg, 1959): is predicated on the premise that there really are regularities in the exercise dispersion from around central location. The Density Saturation Gradient Method (DSGM) could be used to evaluate current land use framework along with prediction of land utilisation structure. The prediction is primarily a pattern perspective of the region's current land use and density structure. The method is most commonly predicated on the uniformity of the downturn in density and point margin saturation with distance from the Central Business District (CBD). This method is equitably concerned with the relationship between length and current density. However, the DSGM is self-contained, this method necessarily requires more subjective input data and means allowing for only a cursory and restricted evaluation of strategy as well as other planning decisions. Three empirical rules are included in this technique:
1. As the range or journey time to the CBD multiplies, the density of land use shrinks.
2. As one moves even farther away from the CBD, the ratio of land in use to available land significantly reduces.
3. The composition of land in an area devoted to each type of land use remains unchanged. Clark established the foundational formula for trying to express the density-distance relationship.
The basic equation:

$$d_x = d_0\, e^{-bx}$$

Where,
d_x=population density at distance x from the city centre
d_0=central density as extrapolated into the CBD of the city
b=density gradient or slope factor
e=base of natural logarithms

The basic Accessibility Model (Hansen, 1959): is based on the notion that the more accessible an area is to various activities and the more unoccupied land area there is, the greater the potential for growth. Thus, growth in a specific region is speculated to be linked to two factors: the region's availability to some regional; activity distribution, as well as the area of land available in the project area.

This concept could be conveyed more officially using the given equations**:**

5/ More formally this concept can be expressed by the following formula:

$$ {}_1A_2 = \frac{S_2}{T_{1-2}^{x}} $$

where:

${}_1A_2$ is a relative measure of the accessibility in zone 1 of an activity in zone 2.

S_2 equals the size of the activity in zone 2; i.e., the number of opportunities for interaction

T_{1-2} equals the separation between zones 1 and 2, expressed in terms of miles, time, or costs.

x is an exponent describing the effect of the separation T on the possibility of an interaction occurring.

Although the size of the activity S and the separation T are denoted by a single symbol; their actual calculation may take a more complex form.

If there are more than two zones involved the formula becomes:

$$ A_1 = \frac{S_1}{T_{1-1}^{x}} + \frac{S_2}{T_{1-2}^{x}} + \cdots \frac{S_n}{T_{1-n}^{x}} $$

Figure 2. 17 : TSAM formula, source: web

The Delphi technique (Powell, 2003): entails repetitively collaborating with a number of individuals to evaluate what or when type of incident is most likely to happen and providing with that the methodical findings on the totality of verdicts submitted by the group. All respondents' responses are accumulated, encapsulated, and given back to the members of the group, who are requested to revaluate. The process obviously varies depending on the specific application, however the final outcome is a general agreement of the decisions of a majority of informed citizens whilst also preventing the bias of leadership influences, face-to-face confrontation, or social dynamics. Participants in a group are expected to clarify their own thinking and final decisions, which will tend to cohere by limiting the range of considerations in reply to the most compelling arguments, as per the hypothesis. Delphi is inclined to take more time & expense than classical prediction models. All of the early versions are commonly regarded as low-cost models based on basic hypotheses. Land use theory's early developments are simple techniques with very little challenges. And each one has a solid foundation and provides a reasonable estimate of land use. They do not, however, account for the interaction of many variables. Some of these techniques were later improved to provide a much better modelling strategy. The inherent theories of this group of models show that there is a broad city-wide philosophy that operates the model, and then zonal allocations are derived through proportioning. Each of these models appears to be logical for forecasting urban land use or activity allocation.

The Empiric Model (Putman, 1979)**:**established for the Boston Regional Planning Project, is aimed to disperse or assign extracellularly provided growth projections of operations such as inhabitants and work opportunities all along zones and sub-divisions of the region under research. This scheduling algorithm requires consideration neighbourhood improvements in the composition of government services and transit systems, as well as changes in community activity patterns. Even though this model emphasizes on inhabitants and work opportunities, it can be augmented to include all activities.

The Lowry Model (Lowry, 1964)**:** integrated both activity production and allotment into its framework. Community and service work opportunities are indeed the activities represented by the model, and all these activities correlate to residences, service, as well as industrial zone uses. Many of the most remarkable features of the Lowry model (Fig. 2.19) are just as follows: a) It assumes an economic base mechanism in which employment is divided into basic and non-basic sectors. Fundamental employment is characterised as employment related with industry sectors whose products are generally utilised outside of the region, whereas service employment's products are consumed inside the geographical area. b) This same location of fundamental sector is considered to be independent of the place of residential neighbourhoods and service outlets. c) Community is apportioned in share to every region's population prospect, and service employment is assigned in percentage to every zone's market opportunity.

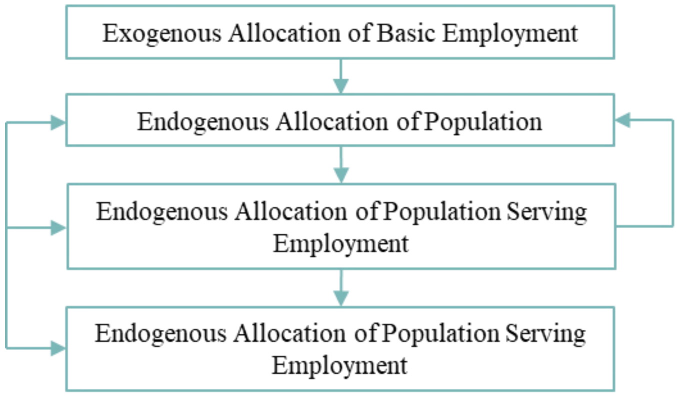


Figure 2.18: Sequence of Activities in Lowry Model. Source: Web result

The Time Oriented Metropolitan Model (Putman, 1979) ***:*** was among the first Lowry model derivatives (Lowri, 1964) . A few of the model's characteristics are as follows: a) The model was developed incrementally, as opposed to Lowry's static equilibrium form. b) It attempts to subdivide the locating population into several populations of various types. It was believed that by disaggregating the model, the model's explanatory power would be increased. c) Restricting the study area to within the city limits. d) TOMM is available in several versions; the structure of the revised model is essentially the same as the original model, though the allocation mechanisms have been made more realistic.

Projective Land Use Model (Kau, 1977)***:*** a further Lowry derivative model family. The Projective Land Use Model (PLUM) is meant to generate forecasts of the sub - district level composition of the population, work opportunities, and land use inside an area based on the dispersion of these characteristics in the foundation year, in conjunction with such a series of simplistic and inherently enticing allocation algorithms. PLUM exists in a range of varieties. Different processes are used to allocate auto and transit modes separately, as well as differentiated local serving categories. The allocation algorithms are based on the Lowry model. This framework distinguishes among fundamental and regional workforce. The allotment feature used for the model has two aspects: a) The likelihood of making a trip for a given purpose of travel of a specified length.

b) The second element is a way of measuring of the terminal's attractiveness. The general PLUM model consists of four phases: preliminary allocation, amended iterative employment allocations, realignment and increments, as well as forecasts. Total residential properties, residential inhabitants, overall number of employed occupants, and overall employment are the outputs of PLUM.

URBAN SIM (Waddell, 2002) (M Alberti, 2000)

: The Oahu Metropolitan Land –Use Model established the initial design of the Urban Sim model as part of a larger effort to develop new travel models. The project entailed the creation of a travel model system that was based on modelling tours rather than trips. The Oregon Department of Transportation launched the Transport and Land Use Model Convergence Project (TULMIP) in 1996 to develop analytical system to enable land use and transport planning. The model was expanded, and the prototype was implemented. The model (Fig. 2.20) was validated in Eugene-Springfield for a test case. Afterward, the model's evolving attributes were scaled, and the model has been used in Utah and Washington (Waddell, 2002), (M Alberti, 2000).

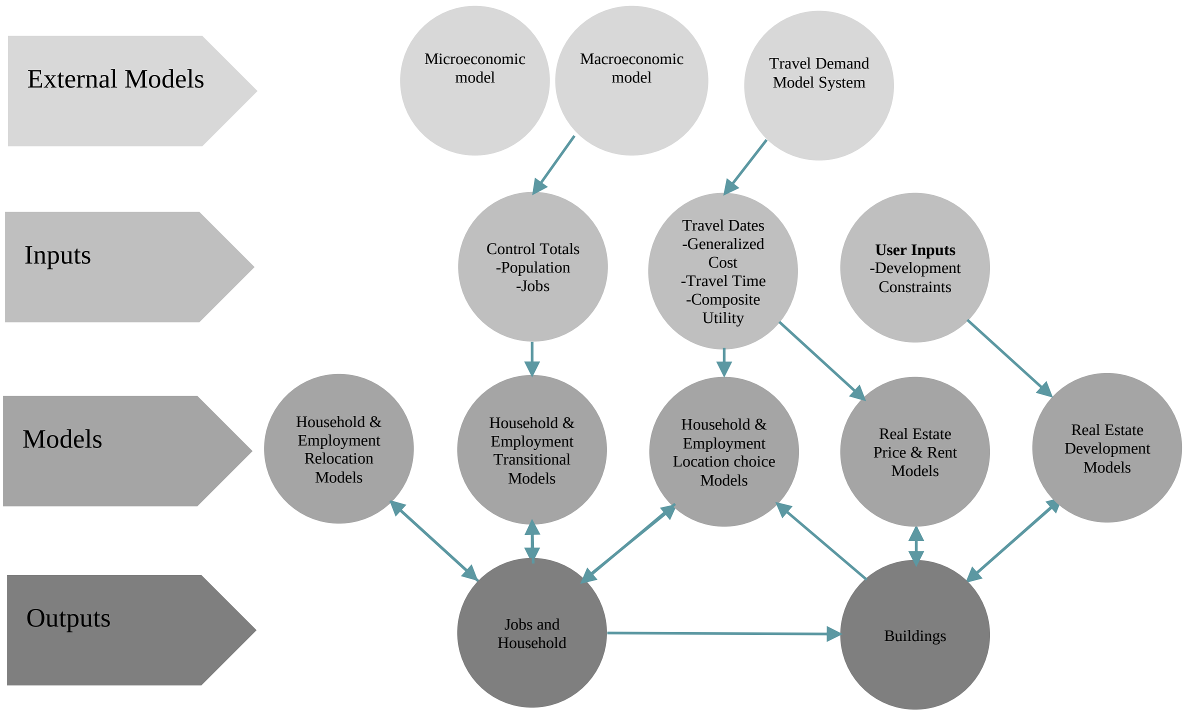


Figure 2. 19 : Urban sim model. Simulates real estate markets by representing the choices of individual households and businesses (or jobs) making location choices. Source: Web result

This same Embedded Model of Residential and Employment Location (IMREL) was developed in partnership with Stockholm's Office of Regional Planning and Urban Transportation (Eliasson & Lundberg, January 2002); (Boyce & Mattsson, 1999). The methodology begins with the sampled households and places of business given at the regional scale. This is not predicted by the prototype but are given extracellularly. These tallies are then divided up all over a system of areas via a procedure of conversations between the residential and employment area data models.

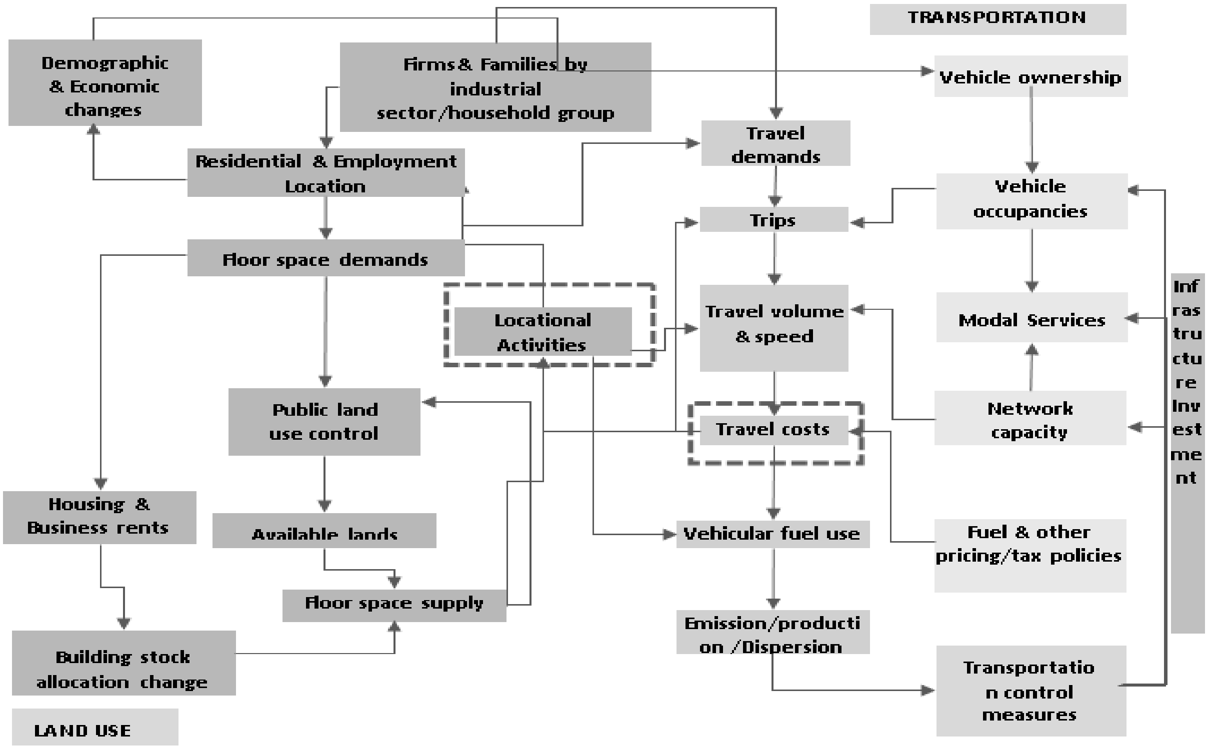


Figure 2. 20 : ***A modeling framework for impact assessment of urban transport systems***, *Source:* (Ambrosino, Sassoli, Bielli, Carotenuto, & Romanazzo, 1999).

2.1.8 Location Choice Model

Many researchers have developed various residential location choice models as an effective tool for analysing actual household demand for housing and better living environments. In this study, a residential location choice model was developed using a discrete choice modelling framework with GIS analysis of LULC mapping, the Delphi Method, and URBANSIM to (1) investigate factors influencing residential location choice in KMA, (2) forecast changes in household residential locations, and (3) derive policy implications for the local housing market. An extensive database of parcels, households, jobs, land prices, and transportation networks is geocoded on the basis of grid cells that measure 150 × 150 metres. A wide range of data of parcels, households, jobs, land prices, and transportation networks is geocoded using grid cells measuring 150 150 metres. According to the estimation results, access to employment opportunities, the ratio of housing cost to income, mixed land use, and the year that housing was built are all important factors in determining household residential locations in the KMA. Furthermore, different age and income groups have different preferences for residential location. Using the estimation results of the residential location choice model, Urban Sim, a highly disaggregated microsimulation model, is used to forecast changes in household residential locations. These advise that diverse income groups display diverse relocation patterns.

The relationship between residential location choice and infrastructure development level, as well as the significance of infrastructure development on housing affordability assessment, are explained later in this thesis, along with a discussion on inclusive housing affordability assessment in India's developing context. As a result, the discussion is divided into three sections:

- Housing location selection and infrastructure inside a metropolitan context
- Level of infrastructure investment inside an urban context
- Inclusionary House Prices within an urban context

2.1.9 Conclusion

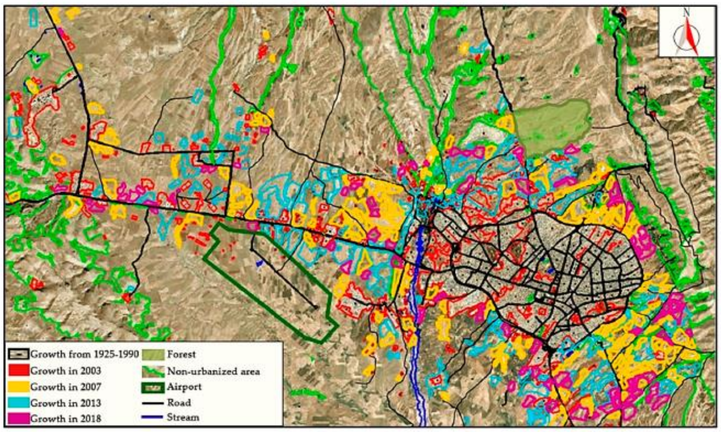
It is concluded that the study for the peri-urban areas for the state of West Bengal is a vivid and elaborated research which starts from a macro level perspective and goes up-to in depth micro level. Hence to conduct the same a various methods and techniques learned from the contextual study.

2.2 Case Studies & Desk Research

2.2.1 Case Studies in Global Context Case 1 & 2

Case 1: *"Urbanization and Urban Sprawl Issues in City Structure: A Case of the Sulaymaniah Iraqi Kurdistan Region"- a paper by Sivan Hisham Al Jarah *, Bo Zhou, Rebaz Jalil Abdullah, Yawen Lu and Wenting Yu.*

This article is based on the case study undertaken in Sulaymaniah, one of several cities with in Kurdistan area in northern Iraq. Sulaymaniah has been well-known for its cultural diversity offerings as well as reliable academic human capital. The economic expansion that accompanied a bunch of political events in 1991 quickened the rate of urbanization. As a consequence, the metro's population increased from 1.36 million in 1991 to 2.2 million in 2018. This was characterized by rapid urban development, mass transit, and an increment in industrial production. Sulaymaniah's urban expansion is a result of excess building development in the city's immediate area, notably in the foothills of the surrounding hills. New buildings are being constructed in all orientations all along ring road sides. It is increasing as a result of booming population density, elevated demand for residential apartments, soaring resident revenue earning, and a wave of new capital investment from international companies. A significant change in the style of residential complexes has been observed as a result of this mass influx. Furthermore, the city's land area has grown significantly. *"The main reasons behind Sulaymaniah sprawl can be the big change in the economic state as a result of political events that took place in Iraq generally and particularly Kurdistan region in 2004 when the region got autonomy from the central government. This administrative autonomy resulted in prosperity in the city activities"* as someone spoke during the field survey of the case study report.



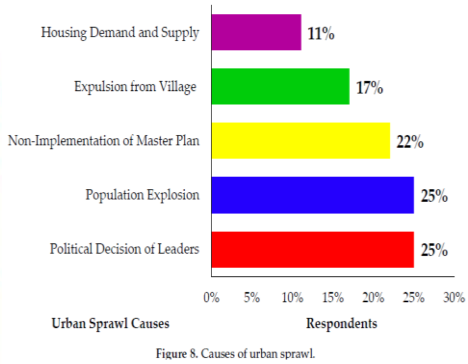


Figure 2. 21 : ***Map of Sulaymaniah city showing the growth area***, *Source: "Urbanization and Urban Sprawl Issues in City Structure: A Case of the Sulaymaniah Iraqi Kurdistan Region"- a paper by Sivan Hisham Al Jarah *, Bo Zhou, Rebaz Jalil Abdullah, Yawen Lu and Wenting Yu*

Case 2: *"Analyzing Urban Sprawl and Effective Development in Dhaka, Bangladesh"- a paper by Lei Wang Provash Kumer Sarker* School of Economics and Management.*

Dhaka is home to an estimated 19.58 million people, with something like an inhabitant of 28 million expected by 2030. Furthermore, in-migration contributes to approximately 63 percent of the overall population growth in Dhaka, also with remaining portion due to the natural increase (RAJUK, 2015-2016). The concentration is higher, especially in the city's core (DNCC and DSCC)1 area, in which it has risen distressingly from 34,635 per km2 in 2001 to 49,182 per km2 in 2018. As a direct consequence, Dhaka is becoming an overcrowded and unsuitable for living environment (Corner, Dewan, & Chakma, 06 June 2013). In this regard, it is important to note that Dhaka is experiencing urban expansion as a consequence of unplanned urban migration, population growth, slapdash housing projects, unplanned establishments of medium-scale manufacturing industries, storage facilities, and low-income housing. For instance, from 2000 to 2010, Dhaka district lost roughly 2.5 hectares of agricultural farmland every day as an outcome of impromptu brick kiln setups, arbitrary housing developments, rising manufacturing systems, and road and infrastructure build-ups. Between 2000 and 2010, agricultural land in Savar shrank from 18,634 hectares to 17,580 hectares due to unplanned brick kilns, manufacturing, and other industry set-ups. Keraniganj has a total land area of 16,997 hectares, with agricultural land shrinking to 9,688 hectares from 11,380 hectares due to haphazard real estate development. Due to the loss of agricultural land, approximately 300,000 farmers in the district were forced to change careers and relocate to cities. Because the urban sector in Bangladesh is the main thrust of the economy, accounting for more than 60% of GDP (KyeongAe Choe, 2011), rural people relocate to the city in search of a richer life and a better lifestyle. Its government offers 43.6 percent of total formal employment in the country, with jobs in the office, business, and manufacturing industries (RAJUK, 2015-2016). Dhaka does have a substantial percentage of informal employment, including rickshaw driving, towing, street vending, and domestic services run by the urban poor. To meet the increasing demands, the vast bulk of agricultural lands and wetlands have been transitioned into hasty and thoughtlessly constructed areas. Dhaka's slapdash spatial expansion ushered in a new era of urbanisation, with far-reaching implications for urban life. Nevertheless, in order to effectively manage the city, the Local Government Amendment Act (2011) divided Dhaka City Corporation in to the Dhaka North City Corporations and Dhaka South City Corporations in 2011 (Hasan & Iqbal, 2015). These two city corporate entities are in control of city services, waste management, social inclusion, and wellbeing projects.

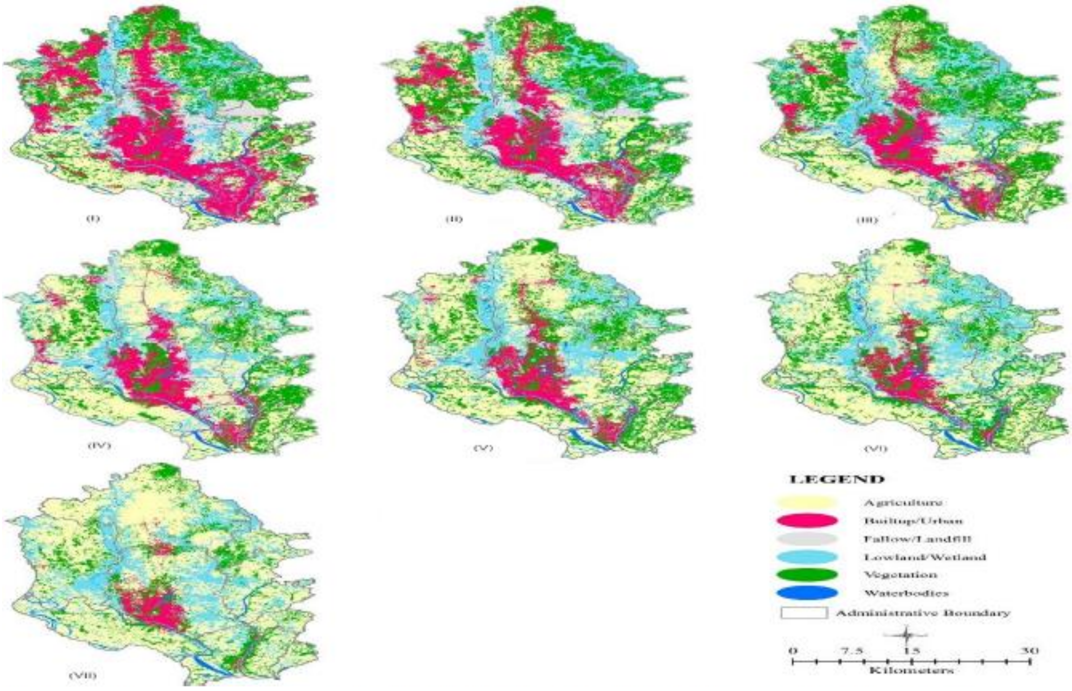


Figure 2. 22 : Land cover maps in greater Dhaka from 1990-2017, *Source: "Analyzing Urban Sprawl and Effective Development in Dhaka, Bangladesh"- a paper by Lei Wang Provash Kumer Sarker* School of Economics and Management.*

	Factors	1 Population Growth	2 Economic Growth	3 Industrialization	4 Urban in-migration	5 Living and property costs	6 Lack of affordable housing	7 Lack of proper planning policies	8 Legal Disputes	Score	Ranking
1	Population Growth		1	1	1	1	1	1	1	7	1st
2	Economic Growth	1		2	2	5	6	2	2	4	4th
3	Industrialization	1	2		4	5	3	3	3	3	5th
4	Urban in-migration	1	4	4		4	4	4	4	6	2nd
5	Living and property costs	1	5	5	4		5	5	5	5	3rd
6	Lack of affordable housing	1	2	3	3	5		6	6	2	6th
7	Lack of proper planning policies	1	2	3	4	5	6		7	1	7th
8	Legal Disputes	1	2	3	4	5	6	8		0	8th

Table 2. 2 : Pairwise Ranking Matrix (PRM)[1] to identify the most dominant urban sprawl factors in Dhaka, Banglaadesh, *Source: "Analyzing Urban Sprawl and Effective Development in Dhaka, Bangladesh"- a paper by Lei Wang Provash Kumer Sarker* School of Economics and Management.*

The authors defined Dhaka's urban sprawl. The remainder of the paper consisted discussion about i) the study's methodological framework. ii) interprets the findings of the analyses of urban sprawl and the factors that contribute to it in Dhaka iii) discusses the effects of urban sprawl, iv) recommends policy tools for megacities' effective development v) and concluding remarks on the affecting factors of peri-urban development.

2.2.1.1 Discussion

Case 1: According to the findings of this study, the region's political autonomy has increased people's income and purchasing power. This is due to the city's commercial success and the establishment of industries. As a result, the real-estate market has experienced increased prosperity, in addition to the implementation of several new investments and projects. Kurdistan has become the most dynamic region of Iraq in terms of development, owing to its share of oil revenues and the region's relative security. Foreign investors are being drawn in, and the economy is clearly booming. The city's concentration of investments and new projects attracts a large number of migrants looking for work. This is not to exaggerate the fact that the Kurdistan region in general, and Sulaymaniah city in particular, have experienced unprecedented growth and development. Nonetheless, the city's sudden and unexpected growth has invariably resulted in abnormal growth, also recognised as urban sprawl. Other factors affecting urban sprawl encompass poor regulation, a dearth of policy development, rural-urban migration, political unrest, political conflict, inequitable land distribution, and war.

Case 2: Between 1990 and 2017, the built-up area density in developing regions (Gazipur, Narayanganj, and Savar) increased significantly. It meant that infrastructure development for industry was taking place, while scattered residential development was taking place in peri-urban areas. A decrease in population density while built-up land increased, implying sprawl. The same scenario applied in the case of outlying areas (Sonargaon, Bandar, Rupganj, Keraniganj). Residential construction was also increasing along the same axis, if somewhat gradually and and along with highways, commute to work roads, and railways. Global expansion in just this manner (i.e., sprawl) leads to improper land use, sparse population, loss of fertile farmland, and environmental collapse. The paper's analyses could assist policymakers maintain the volatility spillover of sprawl on Dhaka's development and environmental resources. Population increase and the continuous growth of industry and business, the metro's ongoing development is spreading its diameter from the banks of the Buriganga River to the southwest, north, northeast, west, and northwest, and trying to extend into rural regions well beyond the periphery after 2010. Further research reveals that the nearness of housing developments is not perpetual but instead erratic. The large percentage of the built-up areas northeast of Gazipur and Tongi are short - circuited and distributed. The growth all along Dhaka-Gazipur highway seems to be contextual; constructed areas are compact close industrial zones, but after 2-3 kilometres ahead, the continuity comes to an end, likely to result in sprawl. That has severe i) social, ii) economic, and iii) environmental consequences.

2.2.1.2 Conclusion

Case 1: To summarise, Sulaymaniah city has grown at a sporadic rate. According to the authors, the city urgently needs practical policies and strategic urban development plans to control unplanned urban growth. New tools are required to monitor urban sprawl, including measuring landscape characteristics and distribution, as well as the extent of urban sprawl. The role of local government in urban settlements is more important in stimulating desired effective future urban development than it is in providing public services. According to the study findings, the city of Sulaymaniah's urban growth management was suffering from a lack of regulation of the organization due to institutional weakness. A systematic response to urban growth was lacking, and the master plan received little attention. Based on the research findings, this study can also be used to give guidance to Sulaymaniah governments in order to produce effective urbanisation management policies that keep in mind all areas of development, which include social, environmental, economic, political, and governance concerns. As a result, equal consideration should be given to the related aspects in order to improve the quality of urbanisation. As a result, more strategic tools must be developed in order to control the dynamics of urban growth and minimise the negative consequences of rapid development. In order to ensure fully considered re-distribution of urban population, provide adequate and affordable housing, improve the quality of urban life, and enhance effective development linkages between urban and rural areas, effective institutions supported by strict regulations and laws regarding urban growth management are critical. Furthermore, the master plan is being revised, and experts, academic professional groups, developers, and community groups are being consulted in order to update policies and strategies to meet the community's new requirements. As a direct consequence, policy tools should be clear and without ambiguity, and planning controls require good governance, which is critical in managing urban sprawl issues. As an outcome, the findings of this study have practical consequences for driving the anticipated urbanisation trajectory in general, but notably for Sulaymaniah city.

Case 2: Recognizing the critical trends in urbanisation and root causes, according to this approach, is a gateway to unravelling challenges in the coming years, and it is critical to implementing the 2030 Agenda for Effective Development, including Effective Development Goal 11 to make cities and human settlements inclusive, safe, and effective. Given Dhaka's precarious situation, it appears that policies to secure the city's future are urgently needed. Figure 3 depicts the overall design of a effective response to make cities more livable and effective. The section that follows discusses the investigation of potential solutions to Dhaka's emerging risks and challenges.

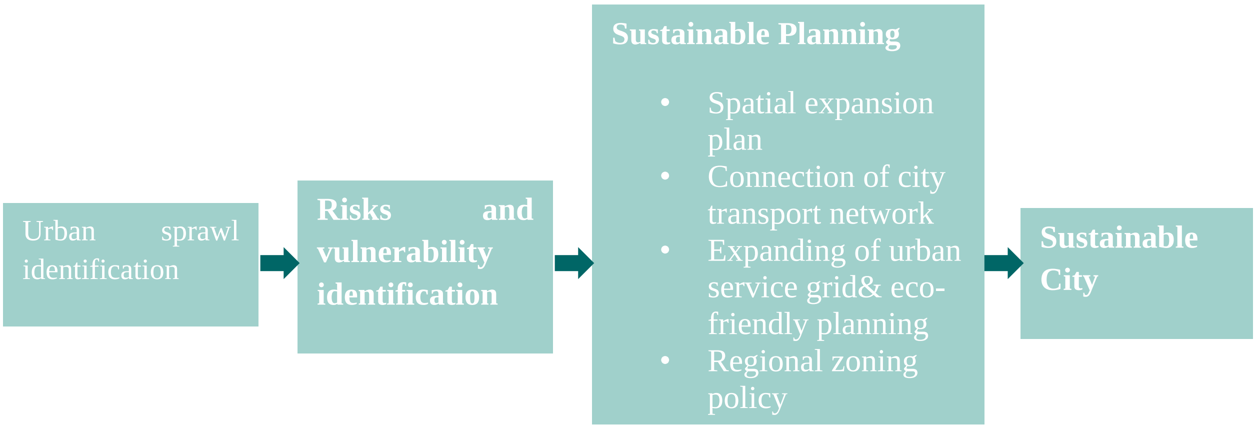


Figure 2. 23 : A framework for Effective Development in Megacity, *Source: "Analyzing Urban Sprawl and Effective Development in Dhaka, Bangladesh"- a paper by Lei Wang Provash Kumer Sarker* School of Economics and Management.*

Some of the thesis's solutions and suggestive outcomes include efficient urban planning, water bodies and waste management, housing policy, infrastructure development for transportation, and public services for the migrant population.

The Effective Development Goals (SDGs) recognise this growing concern and include it in SDG 11: "Make cities and human settlements inclusive, safe, resilient, and effective." In line with this goal, Dhaka's future must be realised as a better mix of urbanised and agricultural spaces. The provision of urban and agricultural areas will necessitate the zoning of agricultural lands and the strict preservation of their status. Simultaneously, forests, hills, water bodies, and wetlands must be strictly conserved. Because Dhaka will have a much larger population in the future, planning for urban-type high-density settlements will be critical.

2.2.2 Case Studies in Indian Context Case 1 & 2

Case 1: *"Sustainability of Urban Fringe Development and Management: A Case Study of Fringe Area of NCT – Delhi"- a paper by Ramakrishna Nallathiga National Institute of Construction Management and Research.*

Background and Study Area: For more than five decades, Delhi has grown in terms of population and geographical area, resulting in the formation of NCT-Delhi. However, the pressure of urbanisation and urban growth is spreading to the surrounding fringe areas, which are undergoing significant change. The haphazard development of unauthorised colonies, piecemeal commercial development, intermixing of conforming and non-conforming land uses, and insufficient services and facilities have all become common features on the fringe. The urban fringe has both significant potential to boost economic development in towns and cities, as well as many valuable environmental, social, and cultural assets that must be protected within long-term development models. The urban fringe, on the other hand, is a territory in its own right, requiring research, policy, and action because it can be both an area of very special characteristics and an area of unusual dynamism and transition. Delhi is India's national capital and has been designated as a separate territory known as the National Capital Territory (NCT) -Delhi. The NCT of Delhi comprises areas administered jointly by the Central Government, the State Government, and three municipal bodies, namely the Municipal Corporation of Delhi (MCD), the New Delhi Municipal Corporation (NDMC), and the Delhi Cantonment Board (DCB). The NCT-Delhi is a part of the National Capital Region (NCR), which includes New Delhi and the surrounding urban areas in the neighbouring states of Haryana, Uttar Pradesh, and Rajasthan. The National Capital Region (NCR) has a population of 25.7 million people and covers an area of 30,242 square kilometres, including 1,483 square kilometres of NCT-Delhi (4.4 percent of total). The NCR encompasses the outskirts of NCT-Delhi as well as a number of other towns. While the State government of NCT-Delhi, MCD, and NDMC are in charge of city planning, the National Capital Region Planning Board (NCRPB) is in charge of regional planning. This part of the city (Ghitorni village) has been taken into account in the master plan for the first time, with the formation of the J zone of the master plan, which appears to envisage a radical shift in the way the area sits in the larger picture of the city.

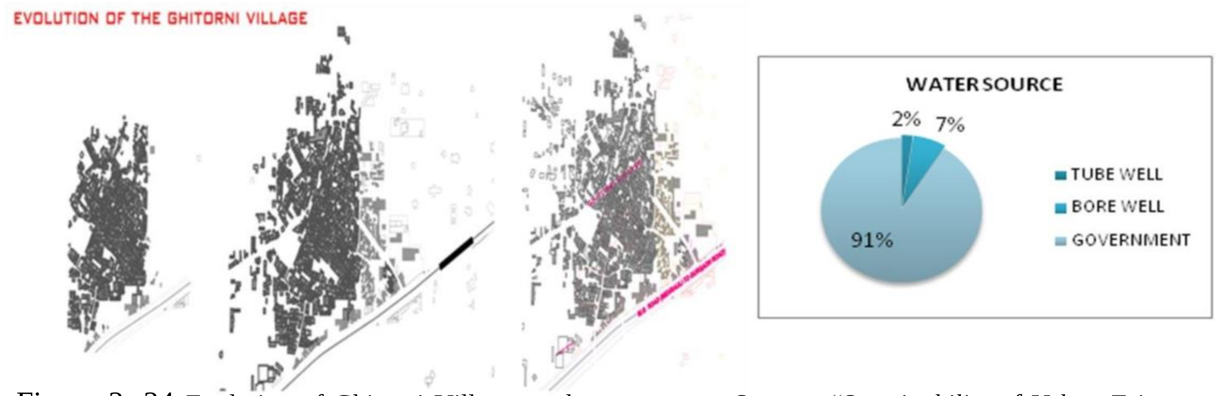


Figure 2. 24 Evolution of Ghitorni Village, *and water source Source: "Sustainability of Urban Fringe Development and Management: A Case Study of Fringe Area of NCT – Delhi"- a paper by Ramakrishna Nallathiga National Institute of Construction Management and Research*

Case 2: *"Peri-urbanization and its impacts on rural livelihoods in Mumbai's urban fringe,"- a Conference Paper · September 2012 by Sohee Minsun Kim, Asian Institute of Technology*

The Mumbai Metropolitan Region (MMR) covers an area of 4,355 km2 and has a population of approximately 17,700,000 people (2011 Census). The MMR is made up of eight municipal corporations, eleven municipal councils for urban municipalities, and 995 village panchayats (rural local bodies). Its administrative region includes the entire district of Greater Mumbai (which includes Mumbai city and the Mumbai suburban district), as well as portions of the districts of Thane and Raigad. In recent decades, the population of Thane and Raigad district has grown faster than that of Greater Mumbai. The Mumbai Metropolitan Region Development Authority (MMRDA), a Maharashtra state government organisation in charge of town planning, development, transportation, and housing in the region, oversees the entire area. Regional development was viewed as a necessity in the late 1960s in order to solve a slew of Mumbai's problems. As a result, in accordance with the establishment of the Regional Plan, a much larger region was integrated for planning. Raigad district is located in the MMR's south-eastern region. The neighbourhood is geographically divided into three sections: 1) coastal lands in the west, 2) a vegetation-covered Central Belt, and 3) north-south running hilly areas and reserved forests of the Sahyadri range.

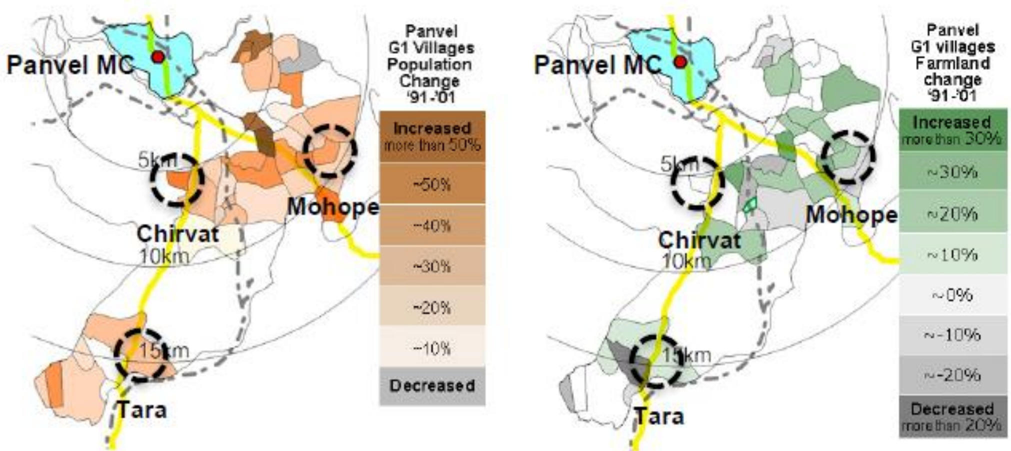


Figure 2. 25 : Village mapping by demographic trends and changes on area of agricultural land around Panvel *Source: ""Peri-urbanization and its impacts on rural livelihoods in Mumbai's urban fringe,"- a Conference Paper · September 2012 by Sohee Minsun Kim, Asian Institute of Technology*

Panvel block is situated in Raigad's east-central province. In the MMR province, it is categorised by competitive pressure between urban and agricultural land use. A case study was undertaken in the villages on the outskirts of Panvel block to evaluate in detail the local physical and socio - economic conditions as a result of the current urban development trend. Green Zone 1 in Panvel block is assigned by Geographic Plan and contains farmland, cultivation areas, and hilly regions to safeguard agricultural production, maintain area for leisure activity usages, as well as detain urban sprawl. Selective developments, such as farm houses, weekend houses on 2000 sq.m. plots, hotels and resorts, and certain obnoxious or hazardous uses with adequate environmental protection measures, are permitted in G-1 Zone by the Development Control Regulations in response to non-remunerative farmers' intention to convert their land for non-agricultural use.

2.2.2.1 Discussion

Case 1:
According to the study, Ghitorni remained a rural village under Gram Panchayat control. Because there was no zonal or local area plan for this zone, most of the areas in this region suffered from a lack of physical and social infrastructure. This region also experienced haphazard and illegal development as a result of a lack of planning. The outcome depicts the evolution of Ghitorni village's spatial pattern of development and explains the key developments in the procedure. Ghotrni has the attributes of an urban village, with farmhouses dominating the land use and a lack of social infrastructure. Residential areas and farmhouses combine to form the primary land-use for the site, according to the Master Plan of Delhi 2021. Apart from sewage, the infrastructure in Ghitorni Village was adequate in 2001. As the village's population grows, the infrastructure can no longer support it, necessitating infrastructure improvements. Ghitorni's water supply is currently about half of the required amount of household water, i.e. 150 litres per head per day (according to NBC norms). Because of an overreliance on ground water as a source of water, its level has dropped to 60 m below ground, which is uneffective for the future. There was no shortage of water available to residents in the year 2000. This figure increased to 25% in 2011

and is expected to increase to 53% of total demand by 2021. Ghitorni currently lacks an organised sewerage system. For storm water drainage, the residents rely entirely on septic tanks and open drains. Ghitorni currently lacks an organised garbage collection system. Residents rely on private waste pickers who charge Rs 50 to Rs 100 per month to collect garbage from door to door and dump it near the MCD dump yard. With only three dumping points and one segregation site serving the village, the majority of garbage is left on the roads to rot and create unsanitary conditions. Ghitorni residents are dissatisfied with the level and quality of civic infrastructure. Poor infrastructure not only affects the quality of urban life and living environment, but it also causes law and order issues and the disfunction of the urban system. The urban fringe areas face a slew of issues that are directly or indirectly related to the deficiency or inefficiency of urban infrastructure services.

Case 2:
Panvel is 7 kilometres, 10 kilometres, and 15 kilometres from Chirvat, Mohope, and Tara, respectively. These villages can be reached in 30-45 minutes by state bus or auto rickshaw from Panvel. Agriculture is the main productive activity for only 10% of the people in the study villages, despite the fact that half of all households have ancestral farming land, they asserted that farming is an ancillary activity done only during the monsoon season. The service industry is the most prevalent type of non-farm exercise, but is mostly in low-wage jobs such as housekeeping, peon (servant), casual labour, and so on. Just the highly educated second or third generation of an upper-class family showed evidence in a surprisingly high paying city occupation, including a desk clerk at a government office or a private corporation. As a result of these issues, crop yields have been reduced, restricting the possibility for excess output and, as a result, urban-rural economic and market linkages reduce.

2.2.2.2 Conclusion

Case 1: The transformation of spatial development in the context of public infrastructure in Ghitorni actually illustrate how such an urban outskirt of the country's capital is discovering itself under pressure and expectations of rapid urbanization and metropolitan attraction while failing to reach the dilemma with a correlating level and type of civic infrastructure. Due to poor institutional structures and a lack of governance – both top and bottom up – there is a significant gap between adequate infrastructure services required and the current state of affairs. People are disappointed with the current condition of infrastructure, but they also have learned to live with it. Initiatives on the frontiers of suitable development policy initiatives, good response approaches to deliver infrastructure and services, and elevating institutional capacity to formulate and execute them within such a set structure of dialogue and collaboration along with timeline are necessary. Ghitorni's perception also illustrates the ineptitude of governments and the community's inadequacy. That's where the governance of urban fringe areas should strengthen on both counts. Effective governance would necessarily entail community involvement, that could be a useful solution for enhancing the performance of the system of governance in land use planning and civic infrastructural facilities. In exercise, however, trying to establish a functional structure that includes stakeholders is a tough challenge. The scope to which involvement of stakeholders achieves or continues to fail is affected by the nature of the method of administration, the main structure for state and stakeholder engagement, the type of involvement of stakeholders, and municipal resources and capabilities. The Dhaka Journey, clearly demonstrates the same.

Case 2: Regardless of the fact that land and forest are the principal means of income for rural people, their rights to land are repeatedly threatened. The land problem is presently becoming magnified by industrialization and urbanization. The emergence in land prices had also attracted brokerage firms and agencies, but it still is inadequate for minor plot owners to consider moving to urban areas. On the otherhand, rich and powerful city residents have started looking for plots for recreational activities, likely to result in a slew of farm houses and hotels and resorts all along highway from Panvel to the hamlets. Landlessness furthermore increases the prospect of dispute in the society among both landless and property owners. In regards to the relationship with outstanding urban centres, comparatively proximal municipalities such as Panvel are indeed the major destination for outmigrants. However, the importance of Mumbai and Navi Mumbai as urban destinations for out-migrants is insignificant. This indicates a lack of employment connections with major urban centres, as well as a significant potential role for town centres in rural livelihood. As a result, those centres and surrounding rural communities must be addressed comprehensively through micro-level area-based rural-urban integrated planning that specifically considers socioeconomic variables and characteristics of the area.

2.2.3 Case Study in Regional Context

"Effect of Urban Sprawl on Human Habitation in Urban Fringe and Peri-Urban Areas in Kolkata Metropolitan Area"- a paper by Sourav Sen, ITPI (Sen S. , 2011)
For the last three decades, the KMA's periphery has been expanding. In 1991, the KMA had a land area of 1,350 square kilometres and a population of 12.5 million people. Most recently, in 2007, the area grew to 1,886.67 square kilometres, and the population surpassed 15.5 million. In 2025, the population of the KMA is expected to reach 22.04 million, with approximately 5.80 million people settling in municipalities and non-municipal areas within the KMA or outside of it. Only that portion of the north eastern KMA, as well as the contiguous areas lying outside the CMD, located between Barasat and Barrackpore of Amdanga Police Station and that between Salt Lake and Barasat via Madhyamgram, has tremendous potential for rapid development. Comparing population growth rates in different municipalities within the KMA from 1981 to 1991 reveals that during that decade, Bidhannagar, North Dum Dum, Khardaha, and Madhyamgram grew at a faster rate. Between 1991 and 2001, the population of Dum Dum, North Dum Dum, Khardaha, Madhyamgram, and Rajarhat Gopalpur increased at an alarming rate. When the population growth rate in the North 24 Parganas district is examined, Barasat Municipality (growth rate of 125.5 percent) trails Dum Dum Municipality (growth rate of 147.3 percent), indicating the direction of the metropolitan area's expansion outwards in a north-east

direction. According to Vision 2025, the annual requirement of houses to house the total projected population within the Kolkata Metropolitan Area is 90,000 per year. According to Vision 2025, the ratio of public sector, private sector, and joint sector involvement in combating housing shortages within the KMA is 18:80:2. The ratio demonstrates that the private sector is the primary contributor to addressing housing shortages.

2.2.3.1 Discussion

The need for more housing has increased the demand for land in Kolkata's core and outskirts. The rising land value trend indicates that the demand for residential land has increased over time. Ballygunge (prime areas), Ballygunge (other areas), Alipore, Park Street, Theatre Road, Gariahat, Rashbehari, Shyambazar, VIP Road, Salt Lake, Tollygunge, Jodhpur Park, Jadavpur, Behala, Garia, Narendrapur, Joka, Poilan, Kona, Madhyam Gram, Jessore Road, B.T Road, Land for development on the outskirts. According to a 2010 survey conducted by NK Realtors, a real estate company, land value has increased significantly in Madhyamgram, Jessore Road, and B.T.Road in Kolkata's north eastern outskirts, as well as Narendrapur Baruipur in the city's southern outskirts. This implies that the most active residential markets in and around Kolkata will expand towards the eastern banks of the Hooghly River.

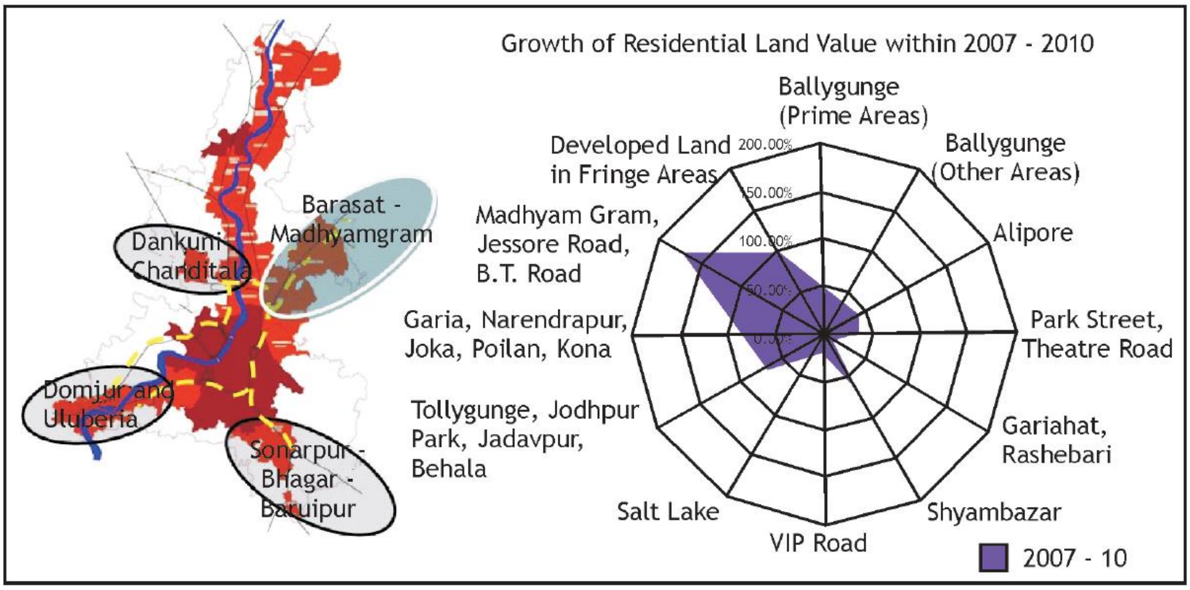


Figure 2. 26 Growth of Residential Land value within 2007-2010 *Source: "Effect of Urban Sprawl on Human Habitation in Urban Fringe and Peri-Urban Areas in Kolkata Metropolitan Area"- a paper by Sourav Sen, ITPI*

2.2.3.2 Conclusion

Although agricultural and orchard land may exist within and adjacent to metropolitan cities, the rise in land values, high rate of land transactions, and high rate of land conversions indicate a strong interest on the part of land developers. This must be identified as a region ready for real estate development as soon as possible. Before some unplanned urban land use is imposed within its rural character, these lands must be considered as urban land. A plan for new settlement areas must be prepared that specifies the best and most appropriate use of those lands in the future, supported by planned infrastructure development and service layout, as well as development control regulations that promote the desired direction of development. As part of control regulations and management, areas of intervention for the public, private (real estate), and joint sectors in these new settlement areas must be specified. Instead of a purely market-driven housing process, the government should focus on public housing projects through joint-sector companies in these peri–urban areas, allowing for some level of control over housing distribution. Aside from multiple investments in existing slum areas, preventing the formation of new slums in the urban periphery is a critical issue.

2.2.4 Inference from Case studies

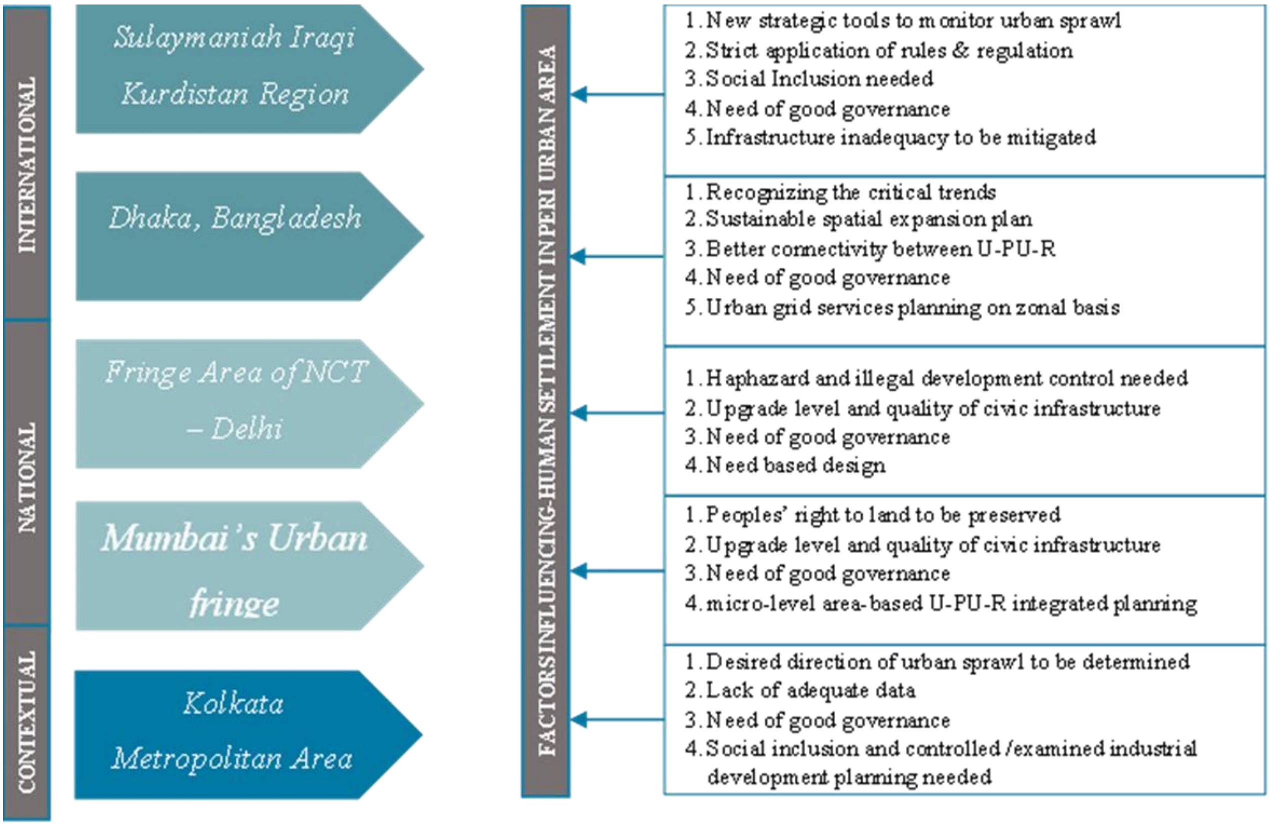


Figure 2. 27 Inferences from International, National, Contextual case studies;
Source: Prepared by author

2.2.5 Desk Research

The data for this research was collected from different sources for the desk research like different national / state level authorities. This part hast been elaborated in the data collection method and process in section 3.6.2

2.2.6 Empirical Theories: Weightage analysis, regression analysis, Models

i) Weightage analysis/ Weighted Index Number Method: The above technique aids in determining a homogeneous region within certain variation/difference limits. Delineation of a region based on literacy rate, for example, may be limited within an area with a specific mean literacy rate with no more than one standard deviation. This method employs the following approach:

a. Identification of criteria such as literacy rate, unemployment rate, watershed, contours, and so on.

b. Assigning weights to the various criteria

c. Establishing homogeneity limits, such as standard deviation.

ii) Regression Model of City Size and Population Growth

This relationship is measured to find out cities of which size grows fastest. The function between city size and population growth would be an inverted-U-shaped relationship: when the city size is small, the growth rate of the population would become higher with the increase of city size; when city size passes an optimal point, the growth would go down with the increase of city size. That is: *(1)*

$$y = ax^3 + bx^2 + cx + d$$

where y is the population growth of city, x represents the population, and a, b, and c are parameters to be estimated.

iii)Urbanization intensity: The Urbanisation intensity index (UII) is calculated to assess the intensity of urbanisation across the entire study area. The Urbanisation Intensity Index can be calculated using the following formula:

$$\mathrm{UII}_{i,t-t+n} = \frac{\frac{(ULAi,t+n-ULAi,t)}{n}}{TLAi}$$

"where $UII_{i,t-t+n}$ is an indice of the intensity of urbanization within a spatial unit i during a time period t to t + n. ULAi, t + n and ULAi, t are the areas of urban land use for years t + n and t respectively and n denotes the number of years. TLAi is the total area of the spatial unit i."

iv) Shannon's Entropy: "Shannon's Entropy (Hn) is used to measure the degree of spatial concentration or dispersion of geophysical variable among n zones (Theil, 1967, Thomas, 1981) using the following equation:"

$$\mathrm{Hn} = -\sum_{1}^{n} Pi \log_e(P_i)$$

"where Pi is the proportion of the variable in the ith zone and n is the total number of zones. Entropy value ranges from 0 to Log (n) Where Log (n) = Maximum limit of Entropy. Here if the value closer to zero indicates very compact distribution whereas the value closer to Log (n) indicates dispersed distribution. As the dispersed settlement indicates sprawl, larger value of entropy reveals the occurrence of urban sprawl (Sudhira et al., 2004)."

v) Index of primacy: "It is the measure of relative importance of the largest town in a nation or a region. Index of
Primacy = P_1/P_2 *Where,*
P_1 *= Population of the largest town and*
P_2 *= population of the second largest town*
There are 2 sets of issues that have generally been debated with regard to primate city urban systems. There are 2 sets of issues which have been by and large debated with respect to primate city urban systems. 1. Concerns with its universal applicability 2. Concerns with its desirability or otherwise."

vi) Rank-size settlement systems: "The concept of rank-size settlement system was suggested by G K ZIPF in 1949. He proposed that if all urban settlements in an area are arranged in descending order of their population, the population of the nth ranking town will be I/n of the largest city.
Thus the population series will be p.p/2, p/3 …. P/n where
P= population of the largest city (Primate city).
$P_n = P_1/n$
P_1*= Primate city population*
N = rank
P_n*= Population of nth ranking city*
The rank-size rule addresses itself to two vital questions: 1. Why larger settlements are fewer in number? 2. What is the relationship between larger and smaller settlements? The explanation to both these questions is based on the appreciation of forces of diversification and unification."

vii) Built-up density: The density of built-up cover per unit area of the village is typically used in ecological studies, but it is now being expanded to improve understanding of urban forms. Map density values are calculated by dividing a village's built-up area by its total geographical area. The computation of built-up density yields a varying degree of distribution of built-up clusters in the study area. High built-up density denotes a clustered or more compact nature of the built-up, and vice versa.

2.3 Conceptual study: Definition and Terminology

Citizen-led co-production: refers to the cooperative improvement of infrastructure services by government and its citizens. Many economically disadvantaged organisations had also decided to seek to switch their involvement with authorities from demanding things to providing collaboration, acknowledging that state agencies could indeed not fulfil their obligations alone, and that economically disadvantaged institutions and federations can enable, configure, and enforce more cost-effective responses (IIED, 2008).

Peri-urban: Regions that are sufficiently close to an urban area, between the suburbs and the countryside. The peri-urban is a zone of social and economic change and spatial restructuring in industrial or post-industrial countries, whereas in much of the global south, it is often a zone of chaotic urbanisation leading to sprawl. Peri-urban zones can be thought of as new multifunctional territories. Common characteristics include low population density, dispersed settlements, a high reliance on transportation for commuting, fragmented communities, and a lack of spatial governance (Ravetz, Fertner, & Nielsen, 2012).

Secondary city: is a term used to describe the second-tier level of a city hierarchy based on population thresholds. Its meaning varies and can refer to the following: population size, administrative area, or the political, economic, and historical significance of a system of cities below the primary order of cities within a country or geographic region. Secondary cities play critical roles in the national and global city systems. They serve as secondary nodes in a complex network of production-distribution supply chains and waste-management recovery systems that connect various spatial levels of human settlement (Roberts, November 2014) .

System of cities: recognises that the emphasis of government policy should be on the relationship between cities, their comparative and complementary expert knowledge, and their transformation in regards to other urban and rural areas (Alvarez, Huet, & Peterson, 2008).

Urbanisation: is the gradual migration of people from rural to urban areas. The percentage of the population residing in urban areas is used to determine urban development levels, and the rate of urbanisation is calculated as the percentage increase in urban population (UNDESA, 2014). Rural-to-urban relocation, natural increases in the population already residing in urban areas, and urbanisation of rural and peri-urban settlements are all sources of urban population growth. From a demographic standpoint, urbanisation is people-centered (Gordon McGranahan, 2014).

Urban areas: are those with a high population density and built-up characteristics in contrast to the surrounding areas. The term can refer to both industrial zones and their associated infrastructure, as well as cities and towns.

Urban Development: The social, cultural, economic, and physical development of cities, as well as the underlying causes of these processes, are referred to as urban development.

Urban growth: An increase in the overall amount of a city's population is referred to as urban growth. This could be at the level of a single settlement or a group of settlements (e.g. at the national level). Urbanization and growth are frequently associated, but not always. The urban population of a country can grow in absolute terms without increasing in relative terms (S Fox, 2016).

Urban expansion: An increment in the built-up area of a settlement or collection of settlements is referred to as urban expansion (e.g. at the national level). This is frequently accompanied by an increase in the size of the urban population (i.e. urban growth). However, urban growth can occur without expansion in contexts of increasing habitation density; conversely, urban expansion can occur without urban growth in contexts of de-densification as suburbanization.

Urban sprawl: The rapid expansion of the geographic extent of cities and towns, often characterised by low-density residential housing, single-use zoning, and increased reliance on the private automobile for transportation, is known as sprawl or suburban sprawl. Urban sprawl is driven in part by the need to accommodate an increasing urban population; however, in many metropolitan areas, it is driven by a desire for more living space and other residential services. Urban sprawl has been associated with increased energy usage, pollution, and growing traffic, as well as a setback of community uniqueness and togetherness. Furthermore, by raising metropolitan areas' physical and environmental "footprints," the phenomenon leads to the destruction of natural areas and the decentralisation of residual nature reserves.

Governance: Even though different individuals identify governance diversely depending on the context and perception, there is agreement on the broad components of governance. While the Webster's Dictionary defines governance as "the act of governing or exercising authority," other definitions are more thorough.

Globalisation: According to WHO, this process can be defined as "*the increased interconnectedness and interdependence of peoples and countries. It is generally understood to include two inter-related elements: the opening of international borders to increasingly fast flows of goods, services, finance, people and ideas; and the changes in institutions and policies at national and international levels that facilitate or promote such flows*". Globalization is defined in geography as the set of processes (economic, social, cultural, technological, and institutional) that make a significant contribution to the correlation between individuals and communities worldwide. It is a rapidly expanding field that amplifies interactions and streams among different areas of the globe.

2.4 Conclusion:

It is concluded that study for the peri-urban areas for the state of West Bengal is a vivid and elaborated research which starts from a regional context in macro level and goes upto in-depth study, analysis and planning in micro scale. Hence to conduct the research various methods and techniques learned from the contextual studies and learning from the case studies has been applied in this research.

3. Research Problem and Methodology

3.1. Need of the study

The peri-urban areas in West Bengal, mostly the areas surrounding the greater Kolkata metropolitan region – the space around urban areas merging into the rural landscape- is growing rapidly. But while most urban areas are now slow growing (at 0.5-0.6% per year), human settlement /built development in peri-urban areas is growing at four times this rate.

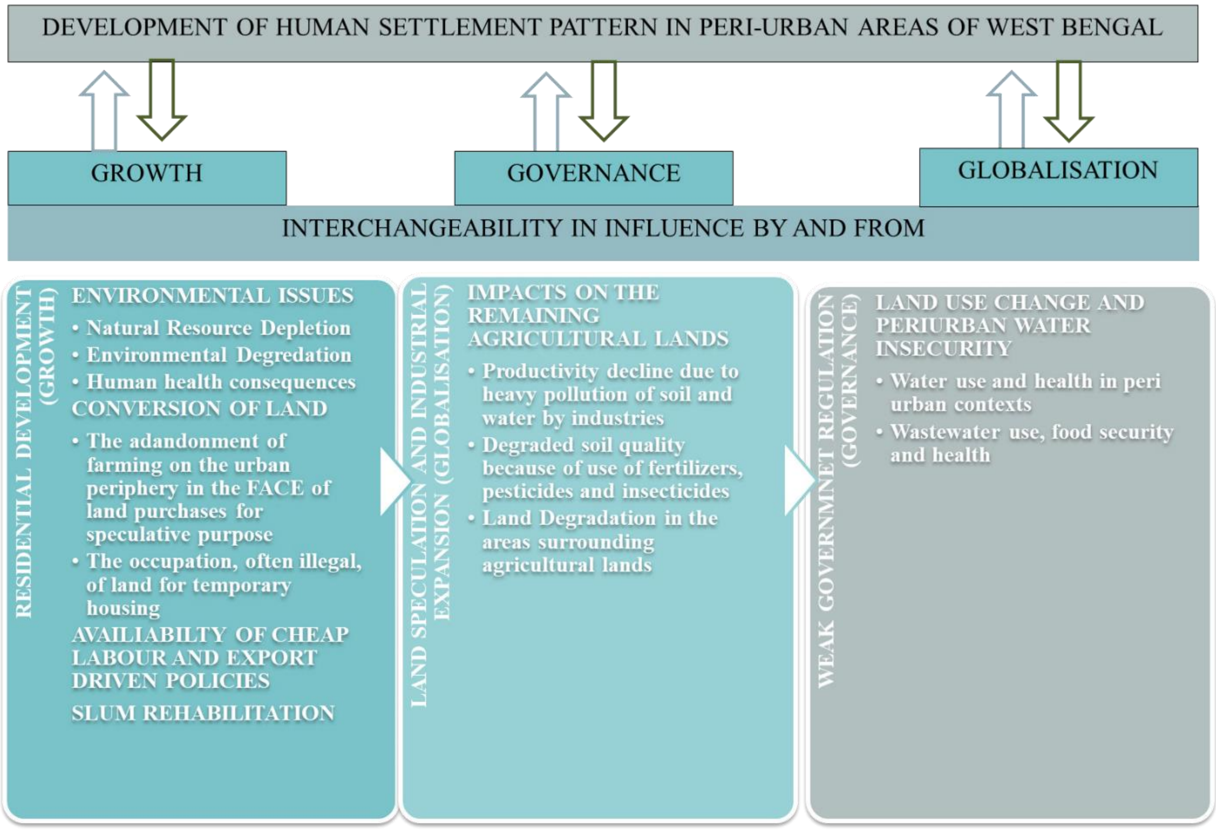


Figure 3. 1: Impact of Growth Governance and Globalisation on Peri-Urbanisation
Source: Prepared by Author based on desk-research data

There are many impacts of such rapid expansion. In many cases the result is sprawl, with increasing problems of social segregation, urban decline, wasted land, and dependency on oil for transport. However, there are examples of alternatives, with opportunities for improved quality of life, green infrastructure, better linkages between city and countryside and more effective urban and rural development (Fig. 3.1).

Overall, the challenges of the peri-urban need to be addressed at the wider strategic level of the surrounding 'rural-urban region'. This requires more effective local government, alongside new forms of social enterprise and cooperation, for integrated development (i.e. joined up policy) in the rural-urban policy.

The formation of human settlements as studies from various datasets in West Bengal absolutely conforms to sporadic non planned ones. The Human Settlements generated on the first half of the last century was not controlled by governance whereas on the latter half governance played a major role in controlling the socio- economic challenges in the newly developed settlements. Growth in population ushered in along with the new built-up developments and the fabric changed its face due to getting affected by globalisation.

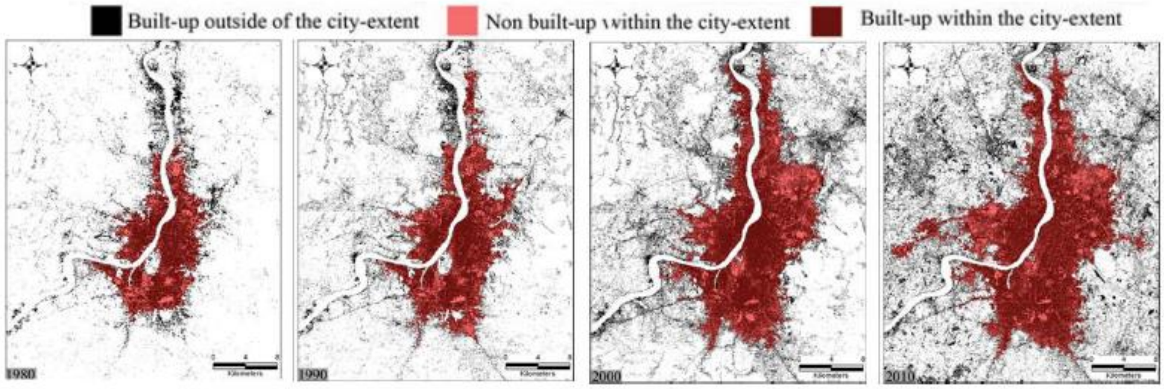


Figure 3. 2 : Kolkata urban Sprawl (Bhatta, 2009)

Kolkata evolved more than 300 years ago linearly in north-south direction along the banks of River Hooghly. Being an old city and also because of its high population density the roads in city core has already been over congested with very limited scope of further intervention (Figure 3.2). Comparing to the core city the sub urban area is still growing. The population growth pattern in KMA also provides evidence for this (Figure 3.3).

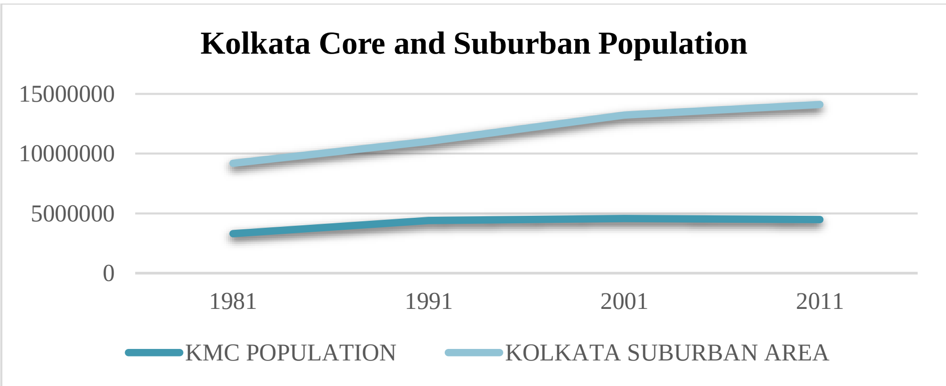


Figure 3. 3 : Population Growth Pattern of KMA; Source: Author

This research focuses on all-encompassing example of urban sprawl of Kolkata Urban Agglomeration around 5 km from its outer limit of official jurisdiction. Its land use analysis has revealed a decline of water bodies from 23.61% (1987) to 6.69% (2015). During 2015 the built up had constituted 32.51%, vegetation comprised of 30.43%, whereas vacant land and agricultural land made up about 19.68% and 10.69% respectively. Increased Shannon's

entropy during 2011 highlights the tendency of sprawl that necessitated policy interventions to provide basic amenities. Spatial pattern through metrics indicated a compact and simple structured growth at the centre of the Kolkata and a distributed complex shape in the buffer region. Further the metrics indicated that the municipalities are on the verge of becoming a single large urban patch that would affect their ecological integrity. Temporal analysis of spatial pattern of urbanisation helps the municipal administration and town planners to visualize and understand the growth of the ULBs so that they can provide better resource planning to create a effective urban area (Mosammama, Niaa, Khanib, Teymouria, & Kazemi, June 2017).
Land in the peri-urban interface is of imperative significance as there is an absence of lucidity in the arranging and strategies in this area whether they ought to be administered under the authority of Local Body Organisation. When all is said in done, these regions are as often as possible disregarded as a particular region in the investigation of urbanisation being neither unadulterated urban nor unadulterated peri-urban. In such manner, an endeavour has been taken to recognize the Spatio-worldly elements of spread, the idea of land change occurred in the distinguished fringe settlements with high likelihood of urban advancement inside the cushion zone of 5 km around the limits of the Kolkata Metropolitan Area.

3.2. Aim

The aim of this thesis to investigate the correlation and impacts of urban growth, governance and globalisation in order to promote alternative sustainable development of human settlement pattern in the peri-urban areas of West Bengal (surrounding KMA).

3.3. Objectives

With aims in view, following set of objectives have been identified for this study:

I. To study urbanisation scenario of West Bengal and identifying major urban growth centre (macro level study area).
II. To delineate the macro level study area with rural-urban growth & peri-urban fringe concept.
III. To analyse local & external factors influencing peri-urbanisation in macro level and selection of micro level study areas for further scope of research.
IV. To analyse the significance of indicators under growth, governance & globalisation influencing the human settlement pattern in the micro level study areas therefore identifying of drawbacks of the existing scenario.
V. To recommend guidelines for policy formation & new tools of intervention for sustainable development of human settlement in peri-urban expansion/growth.

3.4. Scope

The thesis focuses on the peri urban areas of West Bengal and further on to KMA. These areas have fast changing environmental and socio-economic conditions brought about by urbanisation. The population of urbanising rural area is confronted with new problems and possibilities regarding their livelihood and living conditions. In KMA lot of developmental activity is going on in these areas, in lack proper development plan, conditions in this area are degrading rapidly. In the light of this fact, for improving the living conditions, the thesis focuses on finding alternate model & & planning guidelines for stabilised development for human settlement pattern development in peri urban areas of KMA considering land-use pattern, physical infrastructure improvement, transportation and suitable legislation and land use policies.

3.5 Research Questions and expected outcome

This study of peri-urban development is by nature comparative. Various considerations influenced the selection of the regions for study, mainly the distinct growth process, and the socio-economic and socio-cultural structure of migrant households together with the political and economic views of the local and regional governments. The aim of this research is to gain an understanding of the ways that different policies and socioeconomic characteristics drive the particular dynamics of peri-urbanisation in which a variety of spatial transformations and livelihood changes of local residents and migrant households takes place, utilizing either rural-based or urban-based economic sources.

3.5.1 Research Questions

Based on the general conditions of urban growth process in West Bengal and several concepts drawn from theoretical framework, several questions specified below are addressed and become points of reference in field investigation and data collection.:

1) How do we demarcate and define peri urban areas in West Bengal?
2) How has rapid growth taken place in peri-urban areas in west Bengal in times of globalisation?

3) What are the challenges/issues faced by human settlements in peri- urban areas of KMA in West Bengal?

4) What are the Governance strategies that need to be initiated in a Macro and Micro scale to address these challenges/ issues observed?

3.5.2 Expected Outcomes

a) Analyse and estimate the drawbacks of existing scenario of urbanisation in West Bengal.
b) Analyse scheme of an appropriate concept, strategy and planning guidelines to anticipate peri urban human settlement pattern development in (KMA), West Bengal.

c) Analyse the required scheme/ planning techniques for peri urban areas of West Bengal (KMA).
d) Analyse the required infrastructure for socio-economic, socio-cultural, environmental, and infrastructural facilities.
e) Analyse scheme of characteristic changes of Peri-urban areas of West Bengal (KMA) due to globalisation -special consideration to Kolkata Metropolitan Area -the main urban centre of West Bengal.

3.6 Research Methodology & Data Sources

3.6.1 Methodology

Methodology adopted for this thesis covers following stages

a) Study of evolution and growth of KMA (West Bengal) with its historical background.
b) Identification of the peri-urban area and problems related to these areas with relation to 3Gs (Growth, Governance and Globalisation)
c) Literature survey and parallel study carried out earlier for another similar town to draw out relevance to this study
d) Finalization of field survey / study tools and analytical techniques
e) Analysing mechanism and dynamics of peri urban area of KMA (West Bengal)
f) Identification of drawbacks of present growth pattern
g) Development of alternative of peri urban development for KMA (West Bengal)

The methodological sequence as emerged from the methodology adopted has been depicted diagrammatically in a flowchart as shown in figure.3.4

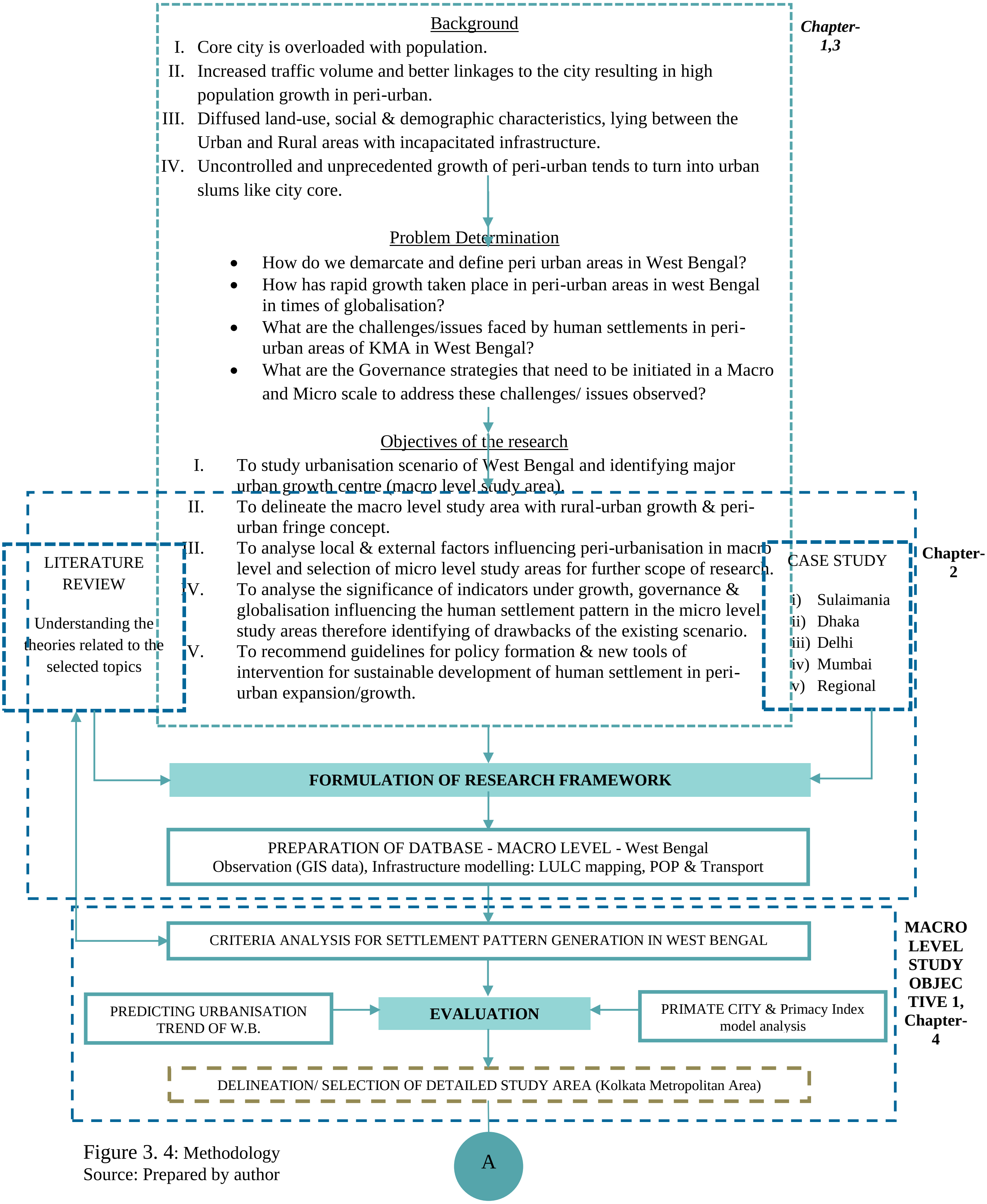


Figure 3. 4: Methodology
Source: Prepared by author

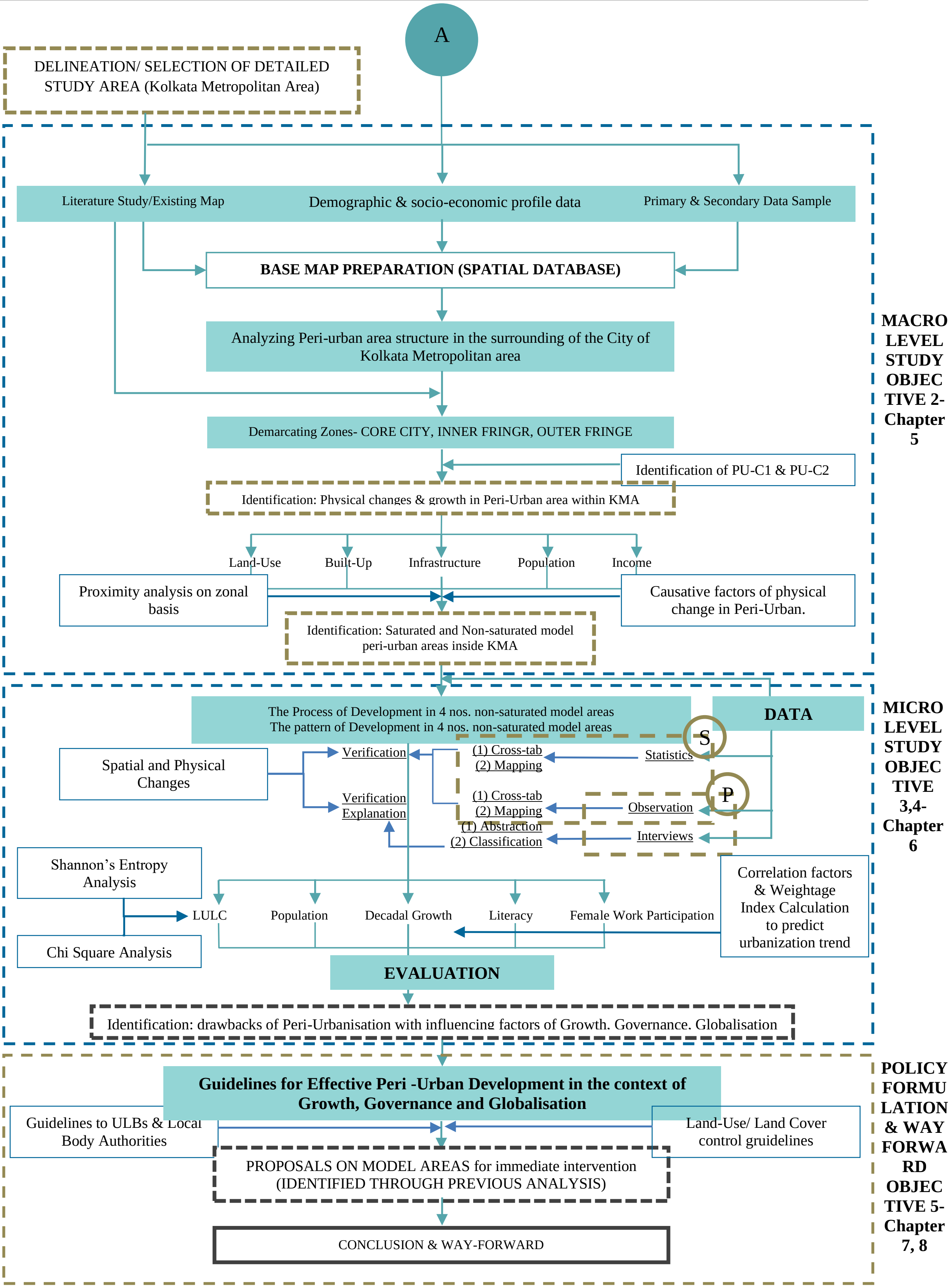


Figure 3. 4 : Methodology
Source: Prepared by author

3.6.2 Data Identification

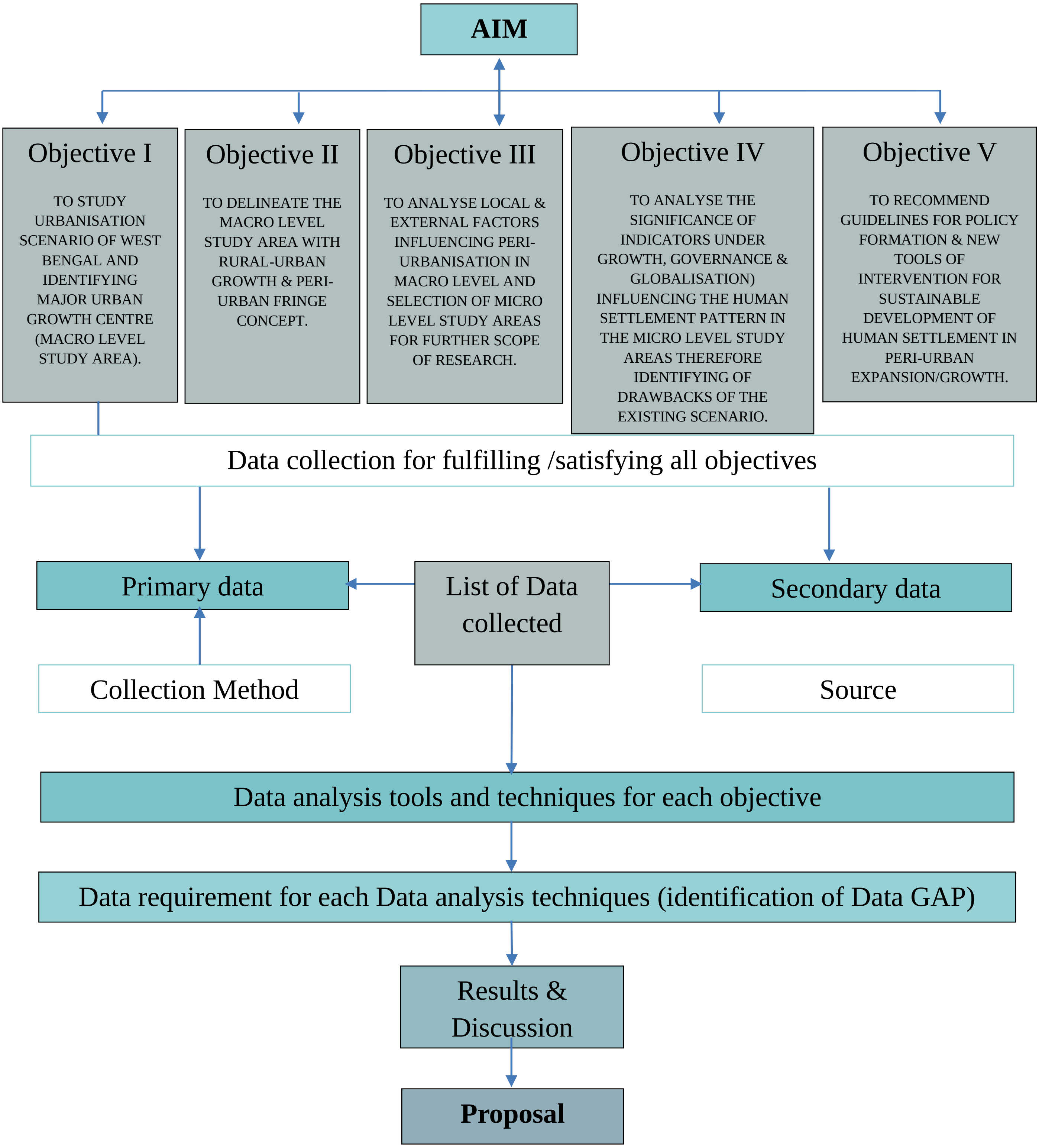


Figure 3. 5 : Methodology for Data processing

Source: Prepared by author

Table 3. 1: **Identification of Data**

Primary Data	
Type of Survey	**Data required**
Land Use Survey	**Built-Up area, Typology of Building, Open Space, Green Space, Waterbodies, Road Inventory, Infrastructure Facility Survey, Public Transport Facility, Major Public services**
Household survey	**Average HH Size, Economic Condition, Work Participation rate, literacy rate, Access to infrastructure(Physical, Social)**
Commercial Survey	**Land price data**
Expert Opinion Survey	**Ranking of parameters that will cause Land-use transition for different types of land-use. Identification and comparative Ranking of CBD**
Secondary data required	
Ward / Mouja wise Population growth	
Detail Development plan, Vision Report (Economic, Infrastructure Planning Report)	
rate of migration/ migration trend - district level	
Existing land-use District & regional level	
Proposed alignment of new corridors and Dist. Headquarters	
Income & Economic profile data	
National & State level guidelines for policy formation	
Spatial Data Required	
Time Line wise Urban Foot print in West Bengal	
Time Line wise Urban Foot print in Kolkata and its hinterland	
Road Network	
Administrative boundary	

3.7 Data Collection methodologies

After identification of data required accomplishing the objective effort has been made to collect those data. A series of primary survey including reconnaissance, Land-use, transportation, Household, Commercial survey has been conducted to understand the existing ground scenario of the study area in District & urban local body level. To identify the growth potential of the model areas in micro level a holistic idea of its sub regional and regional influence is very essential. The regional and sub-regional level data has been collected from secondary data source. The basic data on demography and land use, Road inventory, socioeconomic condition etc has been acquired from KMDA, Sonarpur & Baruipur, Gayespur, Pujali, Uluberia Municipalities, Highway wing (PWD) and various consultancy firms, in the form of maps, feasibility reports, both in hard and soft copy.

3.7.1 Primary Database:

A questioner has been prepared to conduct Household survey separately for municipality, corporation and Panchayat area to identify the average HH Size, Housing affordability range, Quality of infrastructure available in different parts of KMA area, Dailey Average Travel time to commute work space etc. The Sample survey area expanded beyond KMA area to understand the literacy level, Occupational Culture and HH income profile to have a basic understanding on the settlement pattern and delineate the fringe from rural area. For that purpose, few Modifications in survey proforma have been done while surveying outside KMA jurisdiction. Then the data has been analysed and cross checked with available secondary data source to draw the inferences.

Table 3. 2 **: Primary Data sets**

Type	Relevancy
Reconnaissance Survey / Land Use Survey	**Road Geometry, Land Use and Settlement Pattern**
Household Survey in KMA Area **Around and Beyond KMA Area**	**Understand the Economic profile, Literacy rate, Housing affordability, Location Choice to derive the weightage analysis**
Expert Opinion Survey	**To gather a holistic idea on the urbanization trend and settlement pattern of KMA area a detail discussions with the Town Planners of KMDA, other Planners of ULB were done**

3.7.2 Secondary Database:

All secondary data which have been collected in various formats .

Table 3. 3 **: Secondary Database**

Data Type	**Name of report /document /map**	**Source**
Land-use and Land-cover data		
Satelite images of West bengal, Kolkata, KMA areas	USGS Landsat 5 (1991-2011),Landsat 8 2021 in 30mt. grid Google earth	Imported in ArcGIS 10.3
Map of KMA area collected From KMDA	Administrative Boundary Road Network	KMDA
MAPS collected Various ULB	Land use Data, Physical and Social Infrastructure data	Sonarpur & Baruipur , Gayespur, Pujali, Uluberia Municipality
Topo Sheets	Settlement Pattern Geographic profile	Survey of India
Proposed Metro route	Various DPR for proposed Metro corridor	RITES LTD
KMA projections and upcoming planning projects	Kolkata Vision Documents	KMDA
Socio - Economic & Demographic data		
Population Change through decades, Population density.	Census of West Bengal	Directorate of census
Worker Participation rates, income & economic profile	Economic census report	Bureau of Applied economic and statistics, Govt. of West Bengal - 2001, 2008
HH Income range	DDP of Sonarpur, Baruipur , Ulubera, Gayeshpur	Sonarpur & Baruipur , Gayespur, Pujali, Uluberia Municipality
	DPR - Baruipur Township	Project planning unit, KMDA

KMC & KMA Land Market analysis		Study done by CBRE and some research works done by PHD candidate of IIT Khragpur

3.7.3. Analysis

Detailed analysis will be done with the help of GIS tools and techniques to understand the pattern of development and influence of internal and external drivers of peri urbanization.

Understanding the dynamic phenomenon such as urban sprawl requires land use change monitoring, urban sprawl pattern identification and computation of landscape metrics (S, Ramachandra, & Jagadish, 2004). Along with in order to detect and quantify the urban forms such as built-up in terms of spatial phenomenon, the computation of Urbanisation Intensity Index (Suja, Letha, & Varghese, 2013) and the Shannon's entropy (Li, 2004)have been carried out. In order to predict the scenarios of future urban growth Suitability analysis method has been followed. These techniques are discussed below.

i) **Land use and land cover classification**

Information on land use/cover and possibilities for their optimal use is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare (Rawat & Kumar, 2015), (A. Butt, 2015). Followed by the intensive investigation of ground truths Land use analysis has been carried out using the process of multistage unsupervised classification with 30 times iterations to detect the pattern of sprawl and changes in the vast expanse of land cover of the respective area.

ii) **Built-up area density**

The density of built-up cover per unit area of the peri-urban is normally used in ecological investigations and now it is being extended to enhance the understanding of the urban forms. Map density values are computed by dividing area of built up cover to the total geographical area of a peri-urban area of a city. The computation of built-up density gives the distribution of built-up clusters in the study area in varying degrees. High density of built-up refers to clustered or more compact nature of the built-up and vice versa.

iii) **Zonal analysis**

The city boundary along with the buffer region was divided into eight zones at a 45-degree interval considering the central pixels (CBD) to detect the spatial directional variation of intensity of urbanization during 1991–2011.

iv) **Division of zones in concentric circles**

Each zone was divided into concentric circles of incrementing radius of 1 km from the centre of the city. The gradient analysis has helped in visualizing the changes at local levels with the type and role of agents.

v) **Site suitability analysis**

This study has taken an attempt to uphold some growth centres having high degree of urbanization through suitability analysis method using GIS tools. In this perspective along with three major Urban criteria prescribed by Census of India, another three indicators have been considered i.e. rising growth rate of population to indicate, high household density and maximum share of built-up cover to total area, local body initiatives and implementation at grass root level, impact of globalisation.

Multiple case studies are the research strategy to be used in order to gain insight into the different characteristics of development patterns in peri-urban areas, and several methods have been used to address the research questions. First, a survey covering a representative selection of ten villages in the peri-urban area of the city of Yogyakarta was undertaken in between April and July of 2009. A quantitative approach was used in the analysis of the survey results that provided baseline information on the nature of peri-urban development. This analysis provided the foundation for conducting an in-depth investigation. That investigation employed a more qualitative approach. Thus this study mainly relies on the primary data collected by means of field mapping peri-urban land-use change and making sample surveys among heads of households and owners or directors of small and medium enterprises, and by carrying out structured and open interviews with target groups and key informants rather than relying on secondary data with its limitations and validation problems.

3.8. Limitations

A study of this magnitude requires a team of surveyors and staff for collection of the basic data and requires sufficient time. This study has this basic handicap on this account. The other major technical limitations are listed below:

- Due to limitations in carrying out detailed survey and collecting data from primary source at individual level, the study has been based on personal observation and information along with some data collected during course of informal discussions with resident citizens and development officers of the area.

- Reluctance and hesitation on the part of persons including private builders and developers active in fringe areas as well as peri urban areas of KMA in West Bengal.

- Lack of infrastructure and paucity of time to collect information from primary sources by detailed survey due to prevailing pandemic situation of Covid-19 for the last two years.

3.9 Possible outcome

This study will be concluded with appropriate strategies for efficient development of human settlements in the peri urban areas of West Bengal focusing mainly around its primate city Kolkata.

4 Result and interpretation of Objective 1

Objective I: To study urbanisation scenario of West Bengal and identifying major urban growth centre (macro level study area).

This chapter contributes to a better understanding of the rapidly changing spatiality of suburban areas at a regional level of West Bengal, in east India. The aim of this chapter is divided into two sections. The first one deals with high quality maps and an in-depth spatial analysis of the state of West Bengal. This further examines the spatial aspects of generation of new urban human settlements, decadal growth, squatter development, industrial growth and henceforth analysing the rank size rule to select the major location of the primate city. The second one infers a more detailed analogy of the primary study area of the demarcated geography in West Bengal.

4.1 Methodology applied

This chapter deals majorly in two segments with

(i) Critical Analysis of urbanisation characteristics of west Bengal

(ii) Identifying the Peri-Urban study area by means of Rank size Rule and Primate City concept.

The study's dual methodological approach to examining Census Towns: a mixed-methods methodology that examines these new urban geographies from both a macro and micro perspective is a key feature. This strategy is based on a complex Geographical Information System (for macro-state reasons) and local reconnaissance actions (for a micro perspective). Because it covers all communities that have recently been classified as rural to urban, the GIS tells us where to look. Local reconnaissance fieldwork at a well selected field location is required to understand the urbanisation processes that are taking place on the ground.

The three steps of the research are the creation of a geodatabase, mapping and analysis, and reconnaissance fieldwork. The primary goal of the first stage was to gather demographic and economic data, as well as to geolocate all of West Bengal's "urban" Census Towns. The anatomy of 252 Census Towns in 2001 and 780 in 2011 was followed using population enumeration data from the 1981, 1991, 2001, and 2011 Indian censuses, the census town directory, primary census abstract data sets, and West Bengal's nineteen district census handbooks. (Government of India, 2001).

For all of these Census Towns, the district census handbooks (filed in the census under 'Town Amenities') were used to collect data on population size and density. For each of these towns, employment data from the core census tables was used to build economic profiles. The Indian census divides work into four categories: cultivator (those who cultivate their own land), agricultural laborer (wage laborers working on someone else's land), household industry worker (those who work in nonfarm businesses that operate out of their homes), and 'other worker' (people working in occupations other than cultivators, agricultural labourers, or those employed in the household industry). This last category covers a diverse group of nonfarm workers, including teachers and government officials, as well as hawkers, construction workers, factory workers, or those employed in small-scale manufacturing, crafts, retail, healthcare, hospitality and tourism, trade and repair (although the census classifies all of the above as "other workers"). By multiplying the total number of 'household industry employees' and 'other workers' by the total number of workers per settlement, the non-agricultural economic profile for each Census Town was determined using census metadata (Government of India, 2001). The end result is a one-of-a-kind database that contains demographic and economic information for each old (2001) and new (2011) Census Town in West Bengal.

The final step in the database construction process is to locate all of these settlements. Researchers from France's CNRS provided us with a digital boundary file including the boundaries of all administrative settlements in West Bengal (polygons for all villages and towns, for example) (Denis & Marius, 2011). This boundary file contains 41,000 units that can be linked to the census using a unique six-digit settlement identity, referred to in the census as the 'Town/Village Code.' This identity was used to link the Census Towns database to the census unit borders.

In the second part of the research, Census Towns were geolocated using ArcGIS software (version 10.3). Centroids were shown in each polygon corresponding to a Census Town, resulting in a visual representation of their spatial patterning across West Bengal.

All existing major, medium, and small cities (other than Census Towns, which are classified as 'Statutory Towns' in the Indian census) were added to the geodatabase (Government of India, 2019). Using high resolution satellite imagery base maps from Landsat 5 and Landsat 8, we additionally digitized the built-up area of West Bengal's metropolitan agglomerations. Finally, we used National Highways Authority of India road maps (Govt. of India, 2019) to digitize West Bengal's highways. To increase cartographic quality, highways have been smoothed out to match the original input lines (Fitter & Akash Pandey, December 2014).

This geodatabase provides a broad overview of the state's urban system, as well as spatial patterning and trends in Census Town emergence, a geographic understanding of the interaction between established cities and current and future Census Towns, and the role of road infrastructure in Census Town emergence.

In the following step, the focus of the research switched from geodatabase building, map creation, and analysis to fieldwork. The purpose of the fieldwork was to get a sense of what was going on in some of these Census Towns in order to interpret and better understand what was going on there. During research, the focus was on these places' shifting economic geography: the types of industrial expansion, employment prospects, and the character of the local economy, as well as population drift and shift.

A reconnaissance fieldwork survey was conducted in January 2020. Observational data (field notes, photos, and videos) and talks with workers and (small) business owners were the mainstays of the reconnaissance data collection operations.

The degree of urbanisation is related to a number of demographic, social, and cultural characteristics to analyze and explain the spatial patterns indicated by the maps. The percentage of the urban population in relation to the overall population over a specific time period is expressed by the level of urbanisation. As a result, the level of urbanisation is equal to (Urban population / Total population) times 100. The urban concentration index (CI) and the rank size rule are used to analyze the urban hierarchy at the macro level.

It also attempted to analyse urban growth at the district level in order to determine whether or not that technique could be successfully applied at the district level.

The formula for calculating urban concentration is as follows.

$$(CI) = x\text{-}y/2$$

Where x represents the percent of overall urban area in a regional division and y represents the percent of overall population located within its borders.

The rank size rule (Zipf, 1941) has been used to define the connection between population size and settlement in a region using the following technique.

$$P_r = P_i/r$$

Where, P_r is Population of the rth rank city, P_i is Population of the large city; r is Rank of the city. (Sarkar R. , 2019)

4.2 Study of Urbanization pattern of West Bengal

4.2.1 Background & Location:

The mechanism by which the huge aggregate population in communities in and around the urban center expands is known as the urbanization process. Such expansion is influenced not only by industry, but also by the effects of 'globalisation.' The urban population is often dispersed throughout settlements of various sizes and classes, ranging from small towns to enormous cities (Pacione, 1996). Employment possibilities, services, improved housing conditions, high living standards, slums, sanitation, traffic concerns, environmental pollution, health challenges, and so on are all components of urbanization.

West Bengal is located between 22.9868° N, 87.8550° E North latitudes and 86030' East and 89058' East longitudes, and shares three international borders with Bangladesh, Nepal, and Bhutan. It covers an area of approximately 88,752 square kilometres (2.70 percent of India's total geographical area) and stretches from the Himalayas in the north to the Bay of Bengal in the south. It is bounded on the north by Sikkim and Bhutan, on the east by Assam and Bangladesh, on the south by the Bay of Bengal, and on the west by Orissa, Jharkhand, Bihar, and Nepal. According to the 2011 Indian census, West Bengal is the fourth-most populous state in India, with 91,347,736 people (7.55 percent of India's total population). 1029 persons per square kilometers (constantly evolving) is the computed population density by census.

The number of so-called new Census Towns in India increased unexpectedly in the 2011 Indian population census. These are small settlements that meet India's census agency's strict statistical criteria for being labelled "urban": they have a population of over 5,000 people, a population density of at least 400 people per square kilometre, and, most importantly, more than 75 percent of the male working population is engaged in non-agrarian employment (Government of India, 2017a). It is worth noting that these settlements are not 'new,' in the sense that they typically have long agrarian histories. These areas can be thought of as villages becoming urban as livelihoods shift away from agriculture.

According to the census, India saw the gradual emergence of a few hundred of these new urban settlements between the 1950s and 2000s, but this did not amount to substantive urbanisation in terms of population totals (Government of India, 2011); (Duijne & J., 2019). However, between 2001 and 2011, a total of 2,532 new Census Towns appeared out of nowhere across the country's vast rural landscapes, representing an unprecedented and unexpected increase in the number of these small urban geographies (Kanhu Charan Pradhan, 2013). Over that time, India's total urban population increased by 91 million people, with Census Towns accounting for one-third of that increase. It represents a significant shift from India's previous urbanisation experience, which had been dominated by megacity growth until recently (Biswas, Chakraborty, & Satish Chandra, 2017);. East India, specifically the state of West Bengal, has seen a sharp increase in population, with over 500 new Census Towns emerging across the state, accounting for the majority of urban growth during the inter-census period.

4.2.2 Population statistic of West Bengal

West Bengal is currently India's state with the highest population density (Government of India, 2011). Because the river runs through the state and there is no scarcity of fertile lands, farming has historically provided a means of subsistence for the majority of the state's population. During the late nineteenth century, the role of industry in West Bengal expanded, resulting in a population shift to urban areas.

The proportion of the state's population living in cities has steadily increased over time. Around the time of independence, the state's urbanisation rate was 24 percent, well ahead of several other states in the country; and today, about 32 percent of the total population lives in urban areas. What is concerning is that there has been sporadic spatial concentration of urban areas. When the British Indian province of Bengal was divided into two parts in 1947, the eastern region was named East Pakistan – which later became Bangladesh in 1971. The western part of the country was incorporated into India as the state of West Bengal. Millions of refugees fled to West Bengal, establishing settlements and establishing new urban areas.

The characteristics of West Bengal's urban areas are all distinct in their own right. West Bengal is endowed with abundant natural resources, strong people-centred political governance, historic urbanisation, and high population density patterns, which have given way to a rich rural traditional background that contributes to a vivid yet challenging picture of urbanisation. It is the fact that West Bengal's urbanisation rate has been slightly higher than India's. However, urbanisation has always occurred or is occurring in an uneven or unequal manner throughout the region.

The history of urbanisation in West Bengal can be traced back to the late 18th century, when Kolkata, formerly known as Calcutta, emerged as the first port town and commercial city. As the

British brought trade to Calcutta, which led to industrialization, urbanisation was highly concentrated in the region. Calcutta served as the seat of colonial administration and the hub of colonial trade. The majority of the major labour movements from Bihar, Uttar Pradesh, and Orissa (now Odisha) to Assam's tea gardens and African plantations passed through Calcutta. The industrial growth around Calcutta was primarily based on the export-oriented jute industry, which was fuelled by the availability of favourable factors such as access to port facilities, inland water transport via the Ganga-supported river network, and railway infrastructure, which covered a vast hinterland.

West Bengal is now confronted with pockets of overpopulation, ineffective development, infrastructure deficiencies, uncontrolled growth of slums/poor settlements, insufficient municipal services, significant urban pollution, and a slew of other socioeconomic issues.

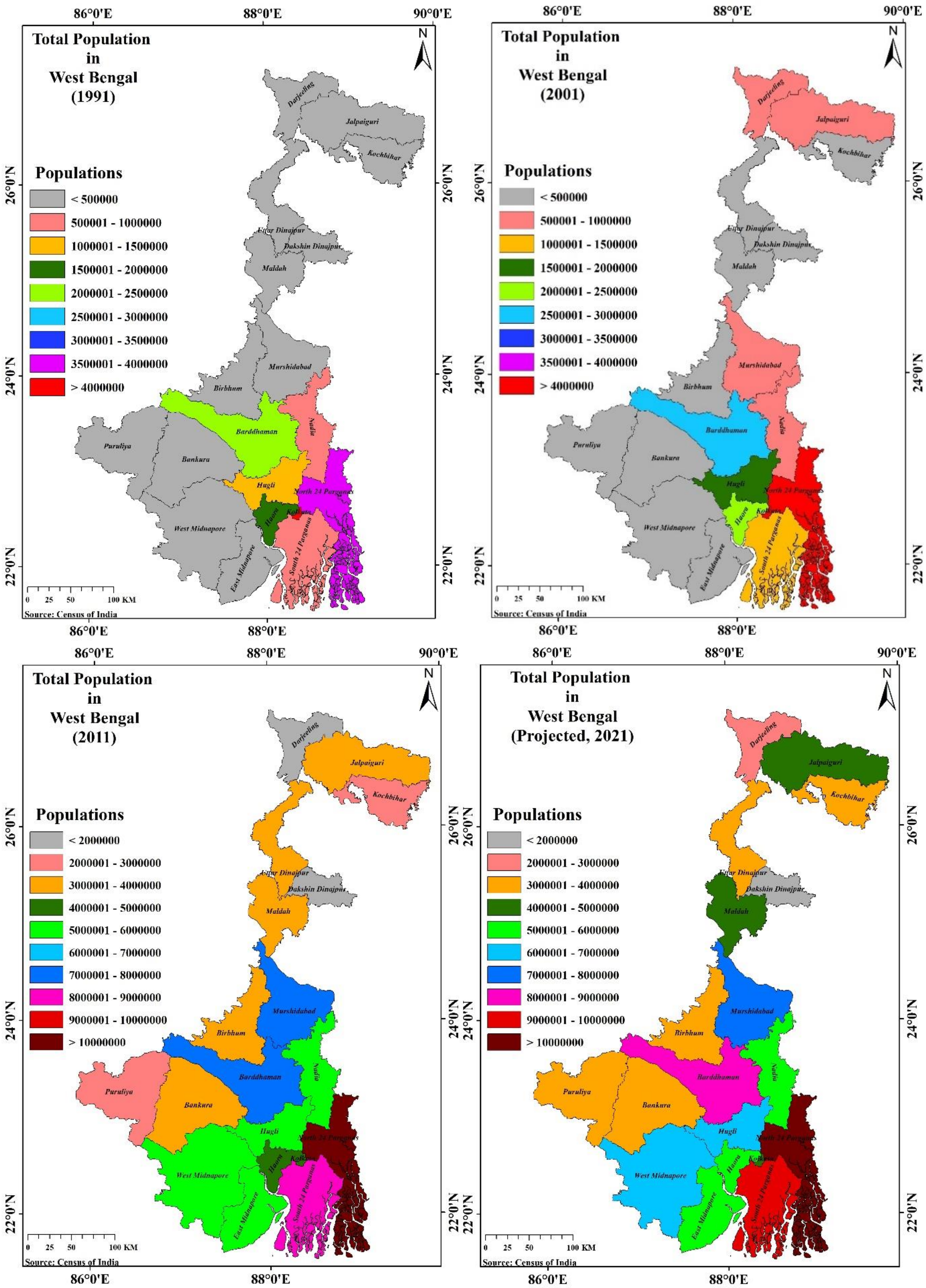


Figure 4. 1 : West Bengal-Population dynamics census year wise
Source: Map generated by author based on Census Data1991, 2001, 2011 and projected 2021

Figure 4.1 shows the dynamics of population growth, shift and drift over decadal node point in census years and also projected graph containing 2021 population assumption.

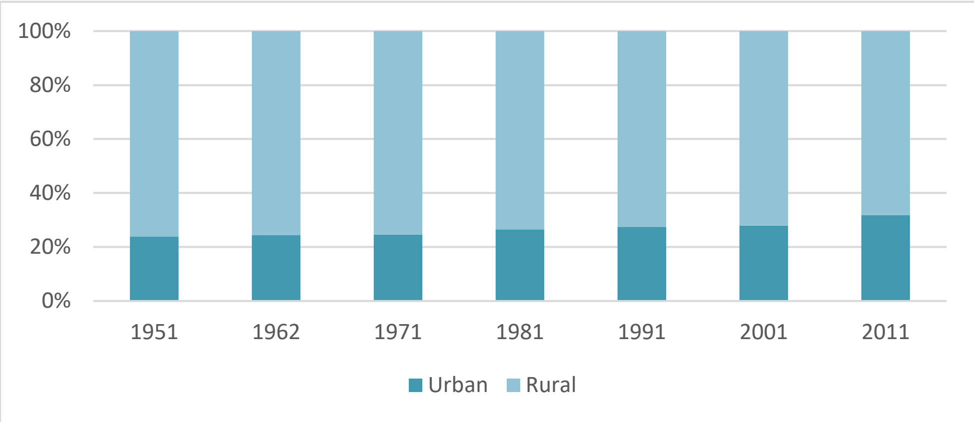


Figure 4. 2 : West Bengal-Rural-Urban distribution of population during 1951-2011(%)
Source: Map generated by author based on Census Data1991, 2001, 2011

As shown in Figure 4.2, West Bengal experienced a slow and largely studied rate of urbanisation until 2001, but the last decade has seen a sudden increase in urban population. According to the estimates, the growth rate of West Bengal's urban population declined between 1961 and 1971, then steadily declined again between 1991 and 2001 before resuming its phenomenal rise in the last decade. Similarly, the urban population growth rate in the ‘river bank' districts increased dramatically from 25% in 1991-2001 to 50% in the following decade. According to Census 2011 provisional data (Government of India, 2011), West Bengal remains one of the most urbanised states in the country, with 32 percent of the state's population residing in urban areas, ranking fourth in the country.

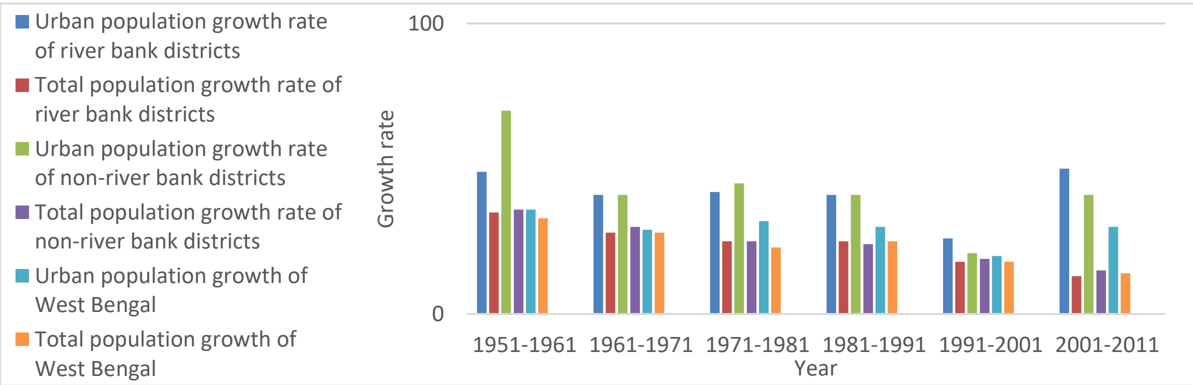


Figure 4. 3 : West Bengal-Urban vs total population during 1951-2011(%)
Source: Calculated by author based on Census Data1991, 2001, 2011 and projected 2021

4.2.3 Migration characteristics and Slum Generation

Migration is a significant influence in the rise of the urban population in the country. Except for Jammu and Kashmir, India's urban population grew by 30.3 percent from 217.6 million people in 1991 to 283.6 million in 2001. According to Census 2001 migration data, 20.5 million persons living in metropolitan regions across the country are newcomers from rural areas who relocated there in the previous decade. West Bengal has also seen a considerable spike in migration in keeping with this trend. West Bengal, after Maharashtra and Delhi, received 5.5 million migrants in 2001, mainly from other states and nations (Government of India, 2011).

Taking a look at the total number of people who moved into major urban areas between 1991 and 2001, it's clear that the Kolkata agglomeration is one of the top destinations, with more than 8.22 lakh people moving there, or around 6.2% of the total population. More than 4.70 lakh of these in-migrants came from the state itself, 2.97 lakh from neighbouring states, and the remaining 55,000 came from foreign countries, like as Bangladesh, Myanmar, and so on (Government of India, 2011).

Due to unchecked development, urban slums and the people who live in them are expanding, creating new challenges for municipal administrations and the surrounding environment (Figure 4.3). West Bengal had 7828 slums in 2000, with 6330 of those unregistered[4]. The number of people living in the state's slums has increased dramatically over time. In 1981, the projected slum population was over 30 lakhs; by 2001, it had risen to almost 66 lakhs, accounting for a stunning 28 percent of the state's entire population. Within the Kolkata Metropolitan Corporation itself, close to 15 lakh people live in slums, making up 39% of the total state slum population. Slum populations are also concentrated in Asansol, Durgapur, Uluberia, and Howrah, all large urban areas. West Bengal's overall slum population is expected to reach 8.5 million by 2011 and 9.1 million by 2017. (Figure 4.4).

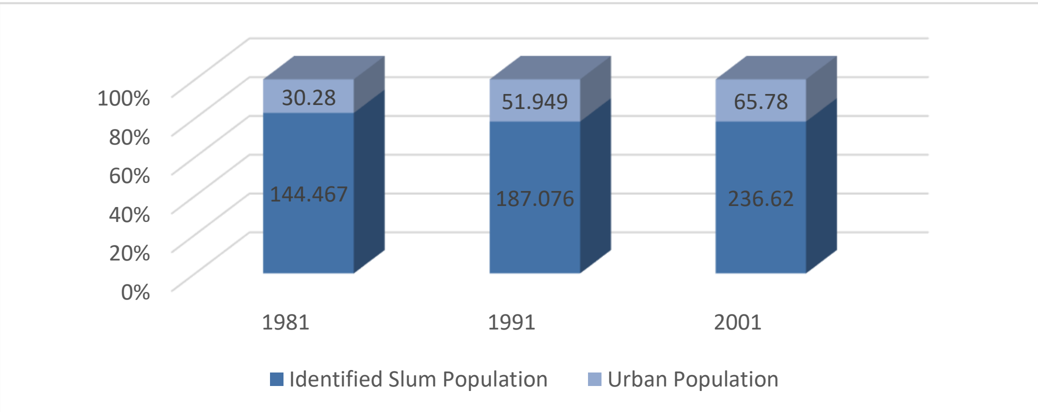


Figure 4. 4 : West Bengal-Identified/Estimated Slum Population (in lakh)
Source: Compiled by author from the statistics released by : A compendium on Indian Slums 1996, Ministry of Housing and Urban Affairs, Govt. of India and Compendium of Environment Statistics, 2000, Central Statistical Organisation, Ministry of Statistics and programme Implementation, Govt. of India, & www.westbengalstat.com

[4] www.westbengalstat.com

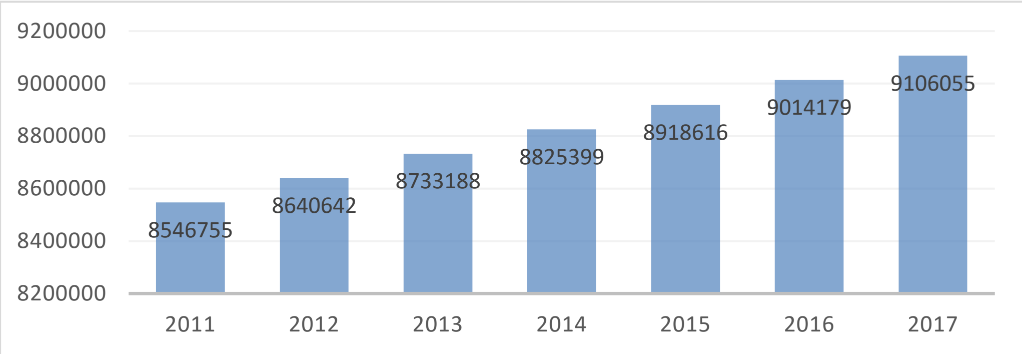


Figure 4. 5: West Bengal-Projection of Population Slum
Source: MoHUA, Govt. of India

As the number of slums and people living in them grows, the quality of life in cities and settlements as a whole suffers. Table 4.1 estimates that in 2002, 373 out of every 1000 slums lacked a sewerage system. In the same time period, there were 294 slums out of 1000 without rubbish disposal arrangements. In 1993, there were 228 slums without drainage facilities and 590 slums with open drainage facilities for every 1000 slums (www.westbengalstat.com). With all of this information, it is apparent that the slum population is suffering, and that this is impacting their health as well as the overall public health of city residents as a whole.

Table 4. 1 : West Bengal-Notified Slum numbers by availability of sewerage per 1000 slums in west Bengal

(July 2002- December 2002)						
States/UTs	Underground Sewerage System				Number of Slums	
	Available	Not Available	N.R.	All	Estimated	Sample
West Bengal	627	373	0	1000	2871	38
	300	700	0	1000	26166	360

Source: Compiled from the statistics released by: condition of Urban Slums, NSS Report No. 486, 58th Round(July2002-December 2002)

4.2.4 Industrialisation scenario in West Bengal

A Historical Account

West Bengal had a long history of being India's industrial economy's leader. Bengal was a major producer of manufactured and industrial goods in India during the ancient and mediaeval periods. The province's abundance of natural resources and access to experienced artisans aided in the extraordinary expansion of cottage industries, particularly in the silk and cotton textile industries. During the colonial period, the industrial sector grew even faster. During this administration, the province began the modern industrialisation process, with the establishment of the first jute mill around 1850. After then, the British turned the region into one of the most important manufacturing centres in India. A contemporary industrialization process was built on the foundation of abundant natural resources, convenient locations, and a highly skilled workforce. Another reason for Bengal's quick industrial growth was the enormous home market in eastern India and neighbouring countries like Nepal, Bhutan, and other Southeast Asian countries. Kolkata was home to numerous well-known industrial conglomerates, including Jessop Engineering, Richardson Cruddas, and Gillanders Arbuthnot & Co.

Industrialization peaked in Bengal at the turn of the century, and the state ranked first nationally in terms of growth in the industrial sector (Sen M. , 1987). Bengal as a whole, and Calcutta in particular, became the eastern half of the country's commercial and industrial hub, with a large concentration of industrial capital. As early as 1948, West Bengal was the most heavily industrialised state in the country, with over 6 lakh people employed in the organised sector. Many of the state's largest public-sector industrial businesses, like as Chittaranjan Locomotive Works, Durgapur Steel Plant, and Damodar Valley Corporation, were built between 1948 and 1962. During this time, most industrial production was focused on export-oriented processing (such as jute), plantations (such as tea), extractive mining, and engineering (e.g., waggon making).

However, things began to change following independence, especially in the early 1960s. The multinational firms and major business houses, controlled Bengal's economy during British rule. However, with the advent of the planning era, growth and expansion of these companies were restrained. Second, as a result of the division of Bengal, the jute and tea industries, as well as migration from the former East Pakistan, were severely harmed, creating enormous population pressure in the state. Third, as has long been disputed, the central government's unfair licencing system and freight equalisation policy engendered hostility against West Bengal. Together with the over-commitment of the colonial firms to unprofitable sectors, these considerations drove many companies to refrain from reinvesting their profits in the state and instead send them abroad or establish commercial units in neighbouring states. Political uncertainty also deterred new investors from putting money into the state.

Because of this, industry growth in West Bengal slowed, and the state finally lagged behind states like Gujarat, Maharashtra, Karnataka and Andhra Pradesh. By the mid-1960s, the state's industrialisation had come to an end, and West Bengal's industrial sector has subsequently experienced rapid decline and acute stagnation. The state's proportion of factory numbers, net value added, and employment has dwindled dramatically over time (Mishra & Mishra, 1997). The growth of all industries, with the exception of electrical products and chemicals, began to slow in the mid-1960s, according to disaggregated data (Banerjee, 1982). Absolute production in numerous industries, such as textiles, iron and steel, paper, etc., fell from 1965 to 1984. This is critical (Sen M. , 1987).

After this long-term slowing down of industry in the state, industrial output and employment declined dramatically, and capital fled to other parts of India in the 1970s and 1980s. This compelled the state government to revaluate its industrial policy, and a new industrial policy was adopted in September 1994 in an effort to bring about a healthy revival in the state's industrial sector. In addition, the state government's attitude toward industry and industrialists has shifted, notably since 1991, when the Indian economy began reforming (Dasgupta, 1998) (Sinha, 2005). As a result of the introduction of new national and state industrial policies, as well as changes in the investment climate, various business groups have expressed an interest in establishing manufacturing units in the state.

In spite of policy improvements, West Bengal originally failed to become an attractive investment destination, especially when contrasted with other industrially developing states in the country. Delicensing and partial freight equalisation under the New Industrial Strategy of 1991 and the 'non-doctrinaire and pragmatic approach' of the state government in the new industrial policy of 1994 could not attract large-scale investors to the state. West Bengal saw very little industrial investment in the 1990s, especially when compared to other major industrial states like Gujarat, Maharashtra, and Tamil Nadu. Low investment inflows have, on the whole, contributed to bad industrial relations, inadequate infrastructure facilities, and low levels of factory production, all of which have led to low profitability in existing manufacturing units. This not only decreased the ability and inclination of these units to invest further in the state, but it also discouraged new investors from investing there.

However, since the dawn of the twenty-first century, investment has begun to rise. Nandigram and Singur land acquisitions have been met with resistance from local farmers, notwithstanding the global economic downturn. However, new investment has significantly changed industry composition even though the state ranked ninth in terms of number of factories and twelfth in terms of output and net value contributed by manufacturers in 2005-06. Chemicals, textiles, coal, iron and steel, engineering goods, leather and leather products, tea, jute products, breweries, paper, drugs and pharmaceuticals, electrical and electronics, plastics, software, locomotives, vegetable oils, and gems and jewellery are among the key industries in West Bengal today. In recent years, the West Bengal government has placed particular emphasis on the expansion and development of the state's electronic industry.

Sectors include iron and steel, petrochemicals, information technology, and food processing have accounted for the majority of new investment. Due to opposition from landowners, the state administration is now focusing on the establishment of industries in areas that are considered backward and have proportionately more uncultivable land. The districts of Paschim Medinipur, Purulia, Bankura, and Birbhum are making efforts to locate new industrial facilities. The state government has designated specific places as industrial growth zones where major manufacturing units can be established depending on the availability of non-agricultural land, industry, and infrastructure. The Raghunathpur Industrial Park in Purulia district and the Vidyasagar Industrial Park in Paschim Medinipur district, for example, are both in the works.

Recent Trend in Industrial Growth in West Bengal

Examination of state decennial growth performance reveals that during the 1970s and 1980s industrial sector generally and the manufacturing sector in particular expanded extremely slowly (Table 4.2). Comparing the performance of the industries over all of India, the growth was even more appalling. During the first decade of economic reforms, the growth rate grew, but this was insufficient to signal a recovery in the industry It has gotten better over the last decade, though.

Growth rates are now higher than all other Indian sectors combined, especially before farmers' protests over land acquisition in Singur and Nandigram got worse. It's worth noting two things right now. In manufacturing and industry, the increase rate of output has accelerated over the years. Second, the state's electricity generation has increased at a quicker rate since the 1980s, but this hasn't translated into increased growth in industry.

As a result of the manufacturing industry's poor growth, the state's share in "net value added" and employment in the sector has been steadily dropping. In employment, the average state share fell from 21.3% in 1960-61 to 1969-70 to a pitiful 5.4 percent in 1990-91 to 1999-2000, while the percentage in 'net value added' fell. Despite the industry's rapid expansion during the last decade, it was unable to reverse the downward trend. Figure 4.6 shows that in 2007-08, the state's proportion of national "net value added" and manufacturing employment fell to 3 percent and 5 percent, respectively.

Table 4. 2 : West Bengal VIS-À-VIS all India-Index of Industrial Production-Compound Growth rate for West Bengal

Period		**Mining & Quarrying**	**Manufacturing**	**Electricity**	**General**
	1970-71 to 1980-81 (With base 1970-71=100)				
West Bengal		0.01	1.82	1.43	1.62
All- India		4.26	4.05	7.33	4.42
	1980-81 to 1992-93 (With base 1980-81=100)				
West Bengal		0.10	1.84	8.80	2.23
All- India		6.94	6.41	8.63	6.75
	1993-94 to 2000-01 (With base 1993-94=100)				
West Bengal		0.78	3.37	6.59	3.62
All- India		3.98	7.63	6.40	7.20
	2000-01 to 2007-08 (P) (With base 2004-05=100)				
West Bengal		5.32	13.05	11.10	11.87
All-India		4.34	8.80	4.89	7.93

Source: Economic Review, Government of West Bengal, Various issues.

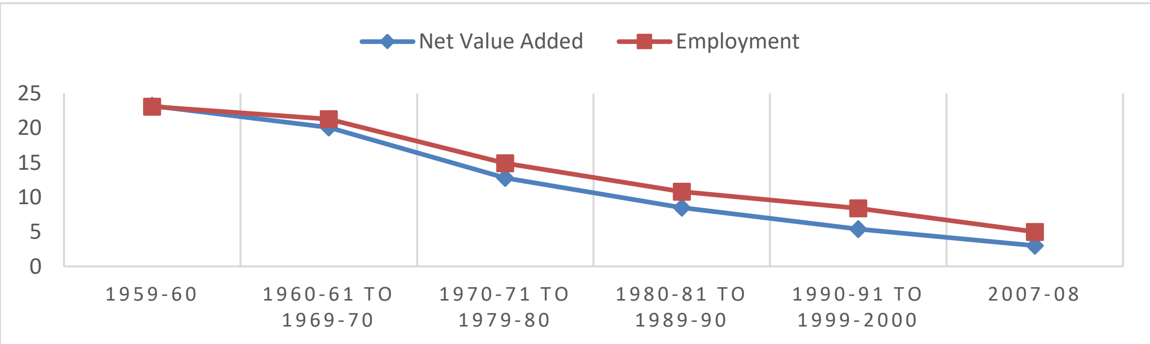


Figure 4. 6: Percentage share of West Bengal in terms NVA & employment
Source: Handbook of statistics of Indian Economy, RBI, various issues.

As can be seen in Figure 4.7, the manufacturing and secondary industries' proportion of NDP dropped dramatically during this time period. From 1960 to 2010, manufacturing's share of the country's GDP fell to 4.2 percent, while the secondary sector's share fell from 10.9 percent to 4.3 percent. While registered manufacturing's share fell sharply, unregistered manufacturing's share rose slightly, but not significantly. This suggests that compared to other states, unstructured manufacturing in West Bengal grew more rapidly. It has been well established that unorganised manufacturing is becoming increasingly important in the state (Bagchi, 1998); (Raychaudhuri & Basu, 2007). However, the peculiar aspect of the rise of unorganised manufacturing is that, while at the national level the sector surpasses organised manufacturing in terms of employment, it plays an important role in West Bengal in terms of output and employment.

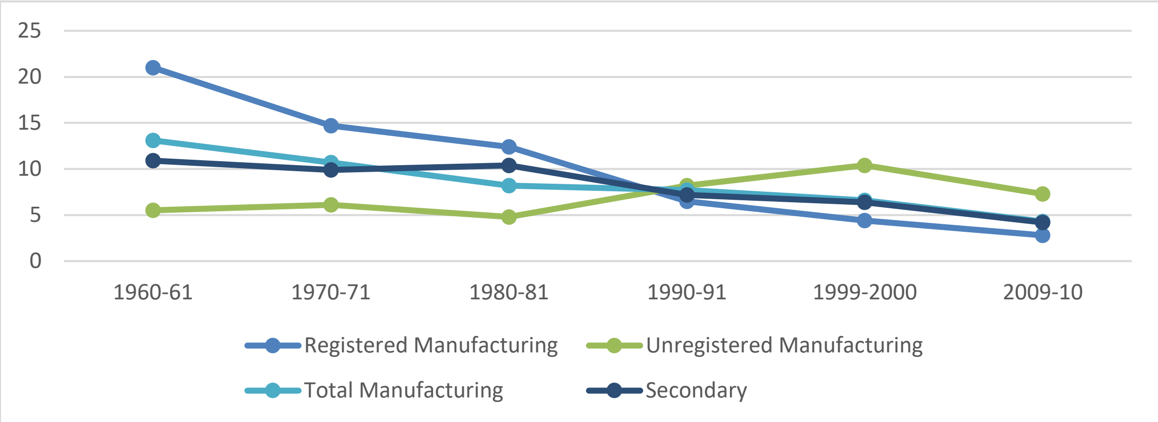


Figure 4. 7: Share of West Bengal manufacturing sector in all-India NDP (%)
Source: National Accounts Statistics, Government of India, various issues

There are several reasons for this decline in the manufacturing and industrial output share of West Bengal, including stronger growth performance in other major states of the country and, as previously said, a weak legislative framework and enabling environment on the state's side. For example, from 1981 to 2010, West Bengal's share of industrial production expanded at a lesser pace than states like Andhra Pradesh, Gujarat, Haryana, Maharashtra, Punjab, and Rajasthan (Figures 4.8). Karnataka, Odisha, Tamil Nadu, and Uttar Pradesh all saw faster increases in their respective shares of the industry sector during the recent decade than did West Bengal. However, over the last three decades, the GDP contribution of services has stayed largely unchanged (Figure 4.9).

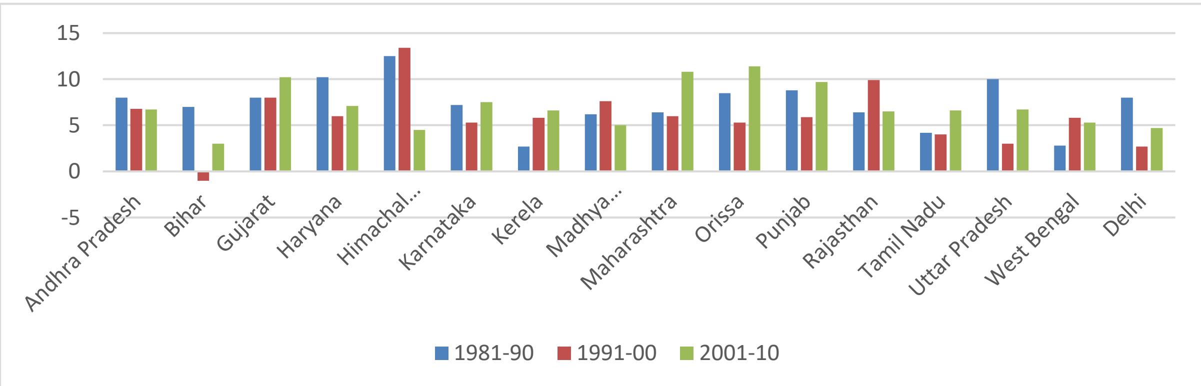


Figure 4. 8 : Comparative Growth Performance: Manufacturing and Industrial Output
Source: Handbook of statistics of Indian Economy(2010-11), RBI

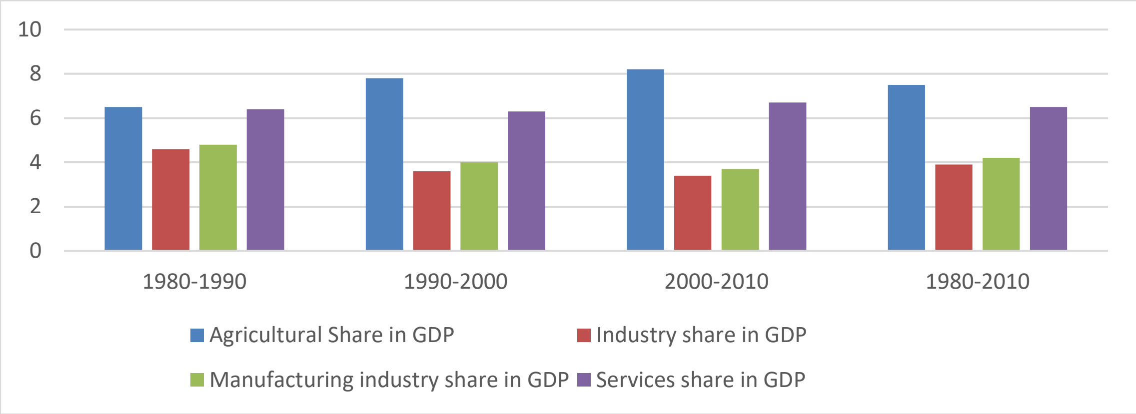


Figure 4. 9 : Sectoral Share of West Bengal in GDP
Source: Handbook of statistics of Indian Economy (2010-11), RBI

Due to the industry sector's underwhelming growth, the composition of NSDP has shifted away from that of NDP. While the participation of the primary and secondary sectors in NSDP has fallen, the decrease is much more pronounced in the manufacturing sector and the secondary sector in general. When looking at GDP composition, however, the levels and trends are somewhat different (Figure 4.10).

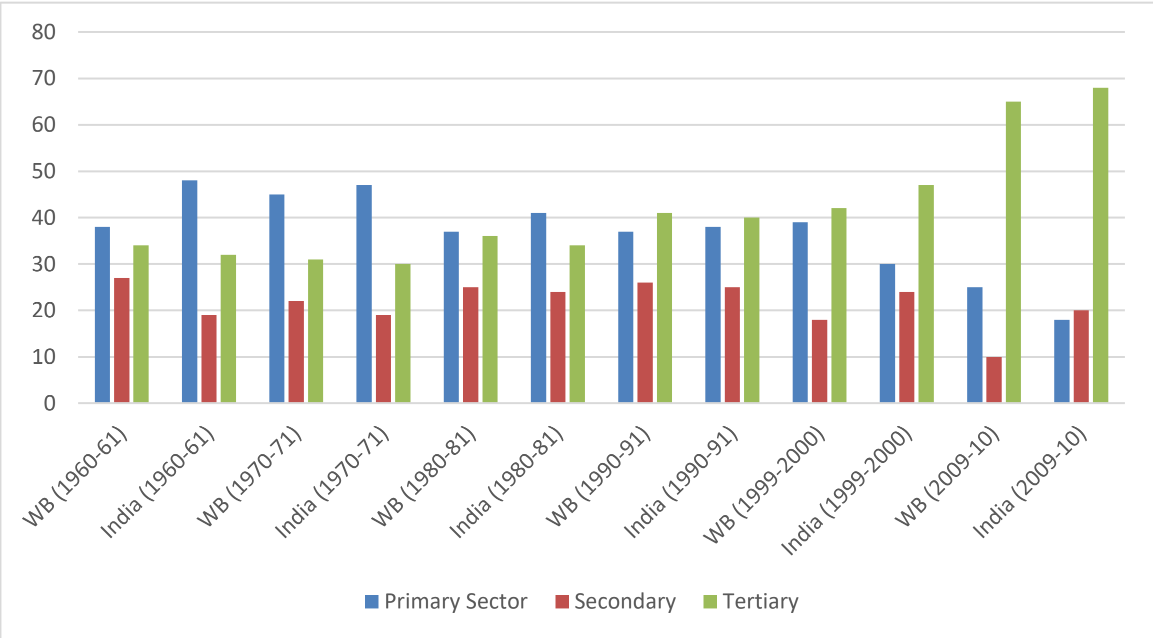


Figure 4. 10 : Composition of NSDP of West Bengal in comparison with India NDP
Source: Handbook of statistics of Indian Economy, RBI, various issues

Industrial Investment Scenario in West Bengal in Post-Reforms Period

West Bengal has launched numerous new projects since the reforms, despite the low growth performance of existing industrial units when compared to other major Indian states. Following a surge in investment bids made, West Bengal has risen to the 8th position in the country (Figure 4.11). The pace at which new projects are being implemented has accelerated, particularly in the recent decade, opening the door for increased industrial production and employment in the state. There have been 2531 new projects implemented in the state between 1991 and 2010, totalling Rs 65,685 crore in investment and providing direct employment for 297,808 people (Table 4.3). According to a breakdown of these new projects by industry, roughly 50% of them are in industries including iron and steel, medications, chemicals, and pharmaceuticals, comprising around 75% of total investment (Table 4.4). Interestingly, agro-based and food-processing industries account for around a quarter of new units, although their average proportion of overall investment from 1998 to 2009 was only about 9 percent. However, the prominence of this industry segment has grown over time. Even while only about 13% of new businesses in the 1990s were in agro-processing, that percentage has risen to 26% in the last decade. To put it another way, from 2.50 percent to 9 percent, this industry's share of new investment has grown. In contrast, the relative position of the jute and textiles sectors has slipped over the last decade as both the number of units and the amount of investment decreased.

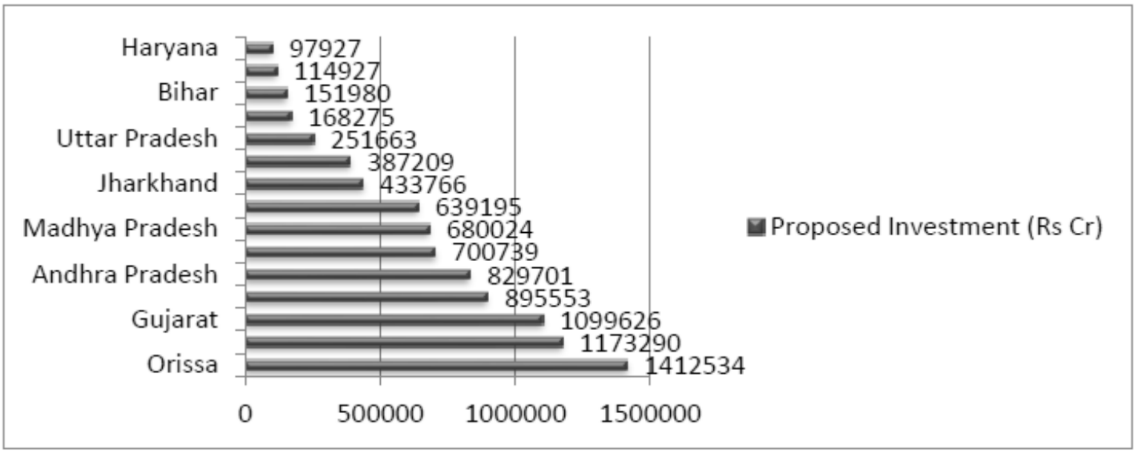


Figure 4. 11 : State – wise share of Proposed Investments for Industries
Source: Annual report 2010-11, Department of Commerce and Industries, Government of West Bengal

Table 4. 3: Industrial projects implemented in West Bengal

Year	No. of Units	Investment catalyst	Direct employment
1991-2000	459	17580.71	62404
2001-2010	2072	48104.19	235404
Total	2531	65684.90	29808

Source: Annual report 2010-11, Department of Commerce and Industries, Government of West Bengal

West Bengal has a substantially higher share of IEMs implemented than the rest of the country. It comes in fourth in terms of completed projects, third in terms of investment, and fourth in terms of jobs created as a result of those projects. A total of 755 projects worth Rs 32,303 crore and creating 138,576 new jobs have been completed. There are a lot of favourable investment destinations like Odisha and Chhattisgarh in this regard, but the state is well ahead of them all (RBI, 2014).

Table 4. 4 :Implementation of projects in different categories, 1991-2010

Sectors	1991-98		1999-2009	
	Units	Investment	Units	Investment
Agro based & food processing	12.66	2.53	26.09	9.07
Iron & Steel	18.33	63.20	21.22	21.77
Jute & Textiles	11.33	12.81	6.60	2.46
Engineering	8.00	4.20	5.55	5.36

Electronics & Electrical	8.00	2.75	1.78	3.14
IT & ITES	10.33	1.42	7.65	4.38
Drugs, Chemicals & Petrochemicals	24.33	11.90	26.87	49.53
Others	7.00	1.19	4.24	4.80
Total	100.00	100.00	100.00	100.00

Source: Annual report 2010-11, Department of Commerce and Industries, Government of West Bengal

Composition of Manufacturing Sector in West Bengal

The decline of traditional industries like jute and textiles, as well as increased investment in sectors like food processing, have shifted the relative importance of different industries in West Bengal's industrial sector. As in 2007-08, food and beverage manufacturing accounted for the vast majority of factories in the state, followed by metals, machinery, and equipment, tobacco and related products, chemicals, and rubber and plastics. Basic metals, on the other hand, account for the largest percentage of invested capital and production value, followed by chemicals and chemical products, while textiles are the largest generator of jobs, followed by basic metals, food products & beverages.

West Bengal is home to 13% of the country's total industries manufacturing tobacco and associated goods when contributions to respective sectors are taken into account. However, these units do not make a major contribution to total capital invested, production produced, or jobs created. A relatively high proportion of overall employment is generated by manufacturers in industries such as textiles, wood and wood products, and basic metals. The number of factories that produce wood and wood-related products is small, but they have a substantial impact on total output and net value added.

Table 4. 5 : Industry-wise (2-digit level) share of selected characteristics in factory sector of West Bengal, 2008-2011(%)

Industries	No. of Factories	Invested capital	No. of workers	Total Persons engaged	Total inputs	Value of Output	Net Value Added
Food Products and Beverages	21.23	8.04	12.09	12.24	11.47	10.71	5.97
Tobacco and Related products	6.88	0.59	2.63	2.52	0.94	0.95	1.12
Textile Products	4.89	6.55	40.02	35.06	5.19	6.22	12.96
Wearing Apparel, Dressing and dyeing of Fur	0.55	0.18	0.38	0.43	0.27	0.28	0.38
Leather and related products	3.88	1.77	1.63	1.78	1.79	1.74	1.44
Wood and wood products	2.97	0.99	1.35	1.41	1.43	1.35	0.93
Paper and paper products	1.95	0.87	1.03	1.13	0.62	0.61	0.51
Publishing and printing related activities	2.46	1.33	0.90	1.29	0.80	1.02	2.39
Coke, petroleum products and nuclear fuel	1.14	9.20	1.01	1.10	16.53	14.94	6.17
Chemical and chemical products	5.68	22.00	3.22	4.62	14.24	14.12	12.22
Rubber and plastic products	5.38	1.59	1.72	1.96	1.56	1.53	1.17
Non- Metallic Mineral Products	3.46	2.12	2.32	2.41	1.92	2.24	4.18
Basic Metals	9.45	31.95	17.22	17.12	29.70	30.14	32.63
Fabricated metal products	6.81	2.15	2.60	3.02	2.14	2.15	2.33
Machinery and Equipment	7.30	1.80	2.29	3.11	2.10	2.21	3.02
Office, Accounting and Computing	0.10	0.35	0.07	0.12	1.49	1.34	0.58
Electrical machinery and apparatus	3.96	1.96	2.20	2.55	2.85	3.02	4.33
Radio, TV and communication equipment	0.55	0.33	0.49	0.39	0.22	0.26	0.46
Medical, Precision and Optical instruments	0.73	0.59	0.37	0.48	0.75	0.78	1.00
Motor vehicles, trailers and semi- trailers	0.48	0.18	0.89	0.92	0.29	0.26	0.46
Other transport equipments	1.75	1.64	2.82	2.89	1.68	1.85	3.17
Furniture and other manufacturing	0.79	0.21	0.30	0.33	0.19	0.19	0.16
Others	7.58	3.63	2.44	2.99	1.82	2.09	2.81
All	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: annual survey of industries (2011)

Geographical Distribution of Industrial Units

Registered factories are disproportionately concentrated in three West Bengal districts: Howrah, the North and the South 24 Parganas. Figure 4.12 shows that about two-thirds of the city's registered factories are located in these three wards, employing over 60 percent of the city's manufacturing workforce. Burdwan and Kolkata are the other two districts with a sizable number of legally registered manufacturing units. Around 14% of the units are located in these two districts, and 13% of the employed staff comes from these areas (Figure 4.13). Like the succeeding sections on urbanisation and density, almost all of these districts are also located in highly populated areas of the state.

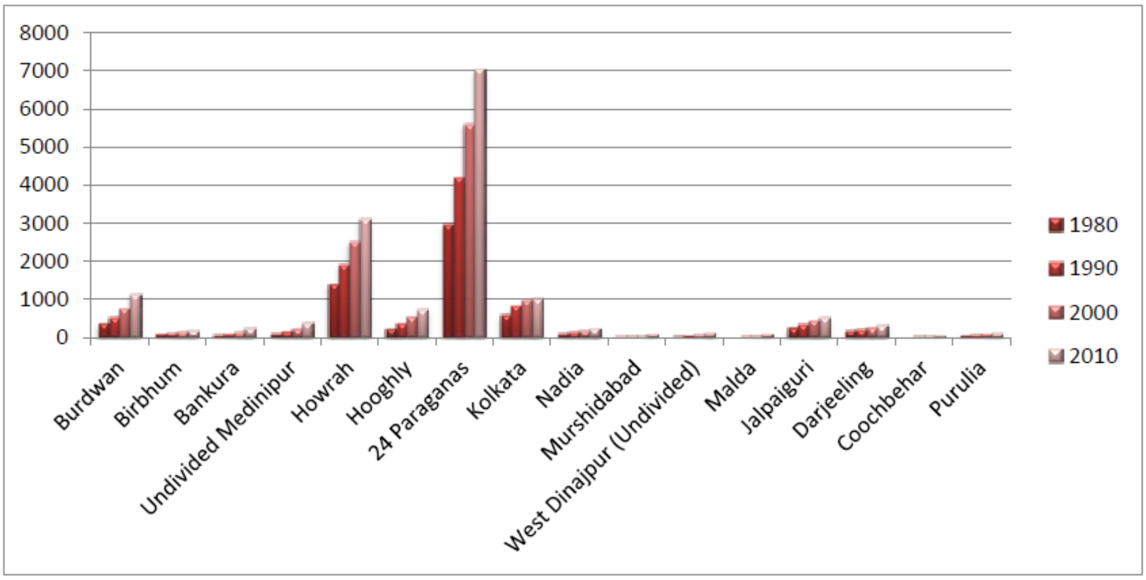


Figure 4. 12 : District -wise no. of registered factories in West Bengal, 1981-2011
Source: Bureau of Applied Economics and statistics, Government of West Bengal

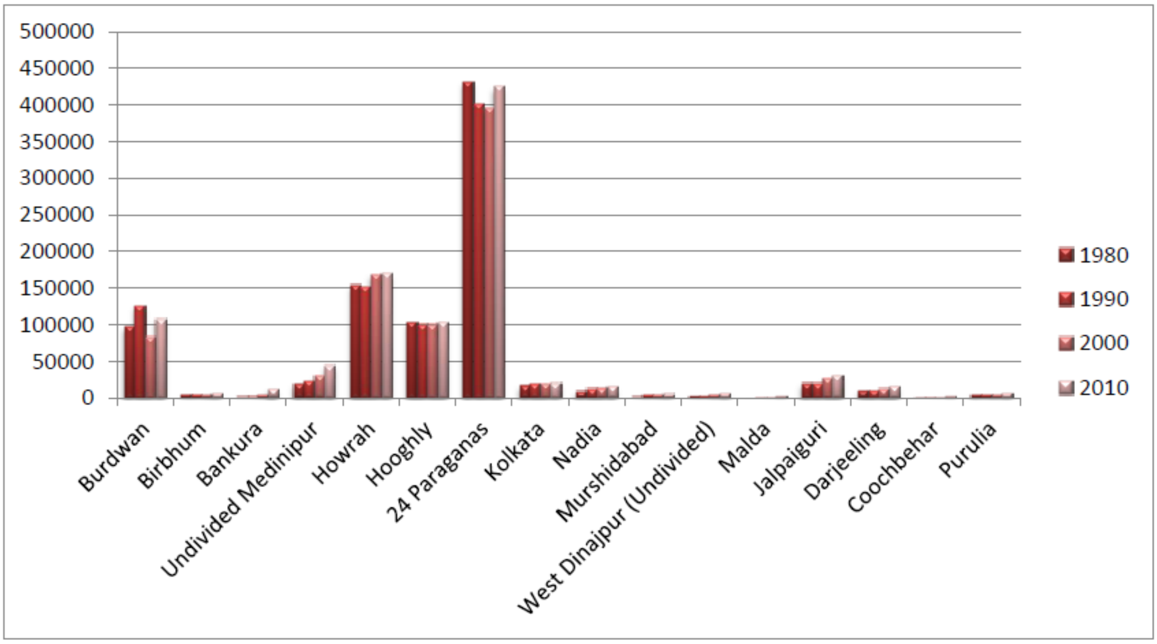


Figure 4. 13 : District -wise Employment Opportunities in West Bengal, 1981-2011
Source: Bureau of Applied Economics and statistics, Government of West Bengal

In contrast, the distribution of the registered micro and small businesses is more evenly distributed throughout the districts. Not only do districts like Howrah, Burdwan and Kolkata contain significant numbers of small businesses but so do Birbhum, undivided Midnapore, Nadia and Murshidabad. What's more, Kolkata is home to the vast majority of apartments. The state has recently created a number of growth centres with all the necessary infrastructure, such as power, land, and water supply. Three major growth centres are also envisaged, one in each of the districts of Birbhum, Jalpaiguri, and Malda.

4.2.5 Growth of Urban Centres in West Bengal

The number of urban centres in West Bengal has increased dramatically in the recent decade, according to the census conducted in 2011. The number of 'census towns' has climbed from 255 in 2001 to 780 in 2011, and the number of statutory towns has increased from 375 in 2001 to 909 in 2011. As of 2001, the state had 58 cities classified as class-I, 29 as class-II, and 56 cities classified as class-III (Figures 4.14 & 4.15). It is interesting to note that as a consequence of forces of development around 580 hitherto villages have graduated to the status of urban areas. As expected, towns and cities are largely concentrated in 'river bank' districts which accounted for almost 90% of class-I cities and 70% of class-II in 2001. North 24 Paraganas alone had a share of 22 cities in 2001 followed by 9 in Hooghly (Table 4.6).

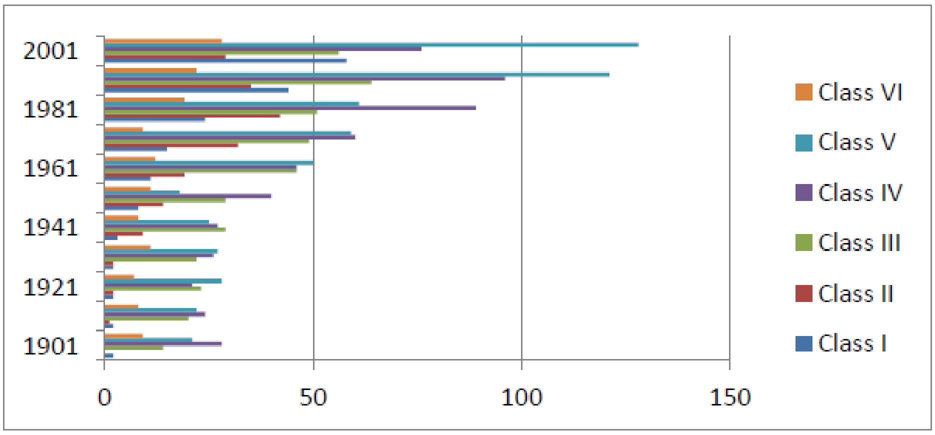


Figure 4. 14 : Number of Town/Cities in West Bengal according to class, 1901-2001
Source: Census Report of India 1981, 1991, 2001

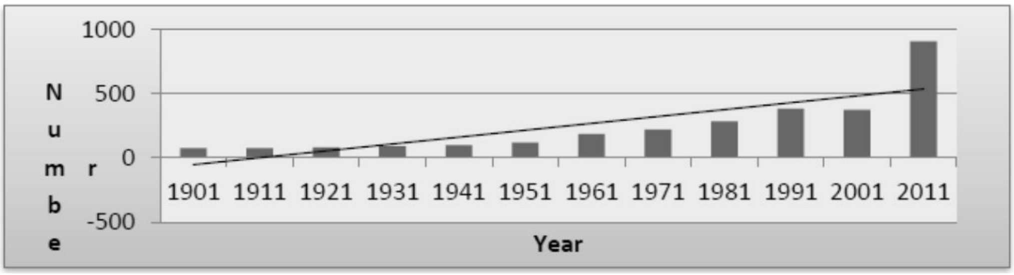


Figure 4. 15 : Number of Town in West Bengal year-wise, 1901-2011
Source: Census Report of India for relevant years

District	I		II		III		IV		V		VI	
	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
River Bank District												
North 24 Paraganas	16	22	7	2	10	4	13	7	11	12	2	1
South 24 Paraganas	0	2	4	1	6	6	11	4	19	6	2	2
Burdwan	5	6	4	2	8	6	15	14	23	27	6	11
Hooghly	6	9	4	2	5	4	7	6	12	16	2	3
Howrah	3	3	1	1	3	7	17	14	22	23	1	5
Kolkata	1	1										
Malda	1	1		1	1		1		1	3		
Midnapore (Undivided)	3	3	2	4	4	4	9	4	1	4	3	2
Murshidabad	1	1	1	3	9	7	1	5	6	13		
Nadia	3	3	4	5	4	3	4	4	11	10	1	
Sub-total	39	51	27	21	50	41	78	58	106	114	17	24
Non River Bank District												
Bankura	1	1	1	1	1	1	1	1	2	1	1	
Birbhum			2	3	4	2				1	1	
Coochbehar			1	1		2	5	5	3	1		1
Darjeeling	1	2	1		2	2	2	2	1	2	2	1
Dakshin Dinajpur	1	1		1	1				1			
Jalpaiguri	1	1	2	1	3	4	5	7	4	2		1
Purulia		1	1		1	3	4	2	3	5	1	1
Uttar Dinajpur	1	1		1	2	1	1	1	1	2		
Sub-total	5	7	8	8	14	15	18	18	15	14	5	4
West Bengal	44	58	35	29	64	56	96	76	121	128	22	28

Table 4. 6: West Bengal: District-wise cities
Source: Census of India: data of relevant years

It's also worth noting that the percentage of people living in Class-I cities has increased over time. Class II, III, and IV cities, on the other hand, have seen a decrease in population proportion. However, a rising trend can be seen in the last two categories (Figure 4.16). All of this demonstrates the magnitude of the issues that have arisen as a result of West Bengal's rapid and varied urbanisation. Class-I cities' rapid growth, both in terms of population and area, could be a serious threat to the health of the river basin as a whole, as well as to public health, safety, and quality of life.

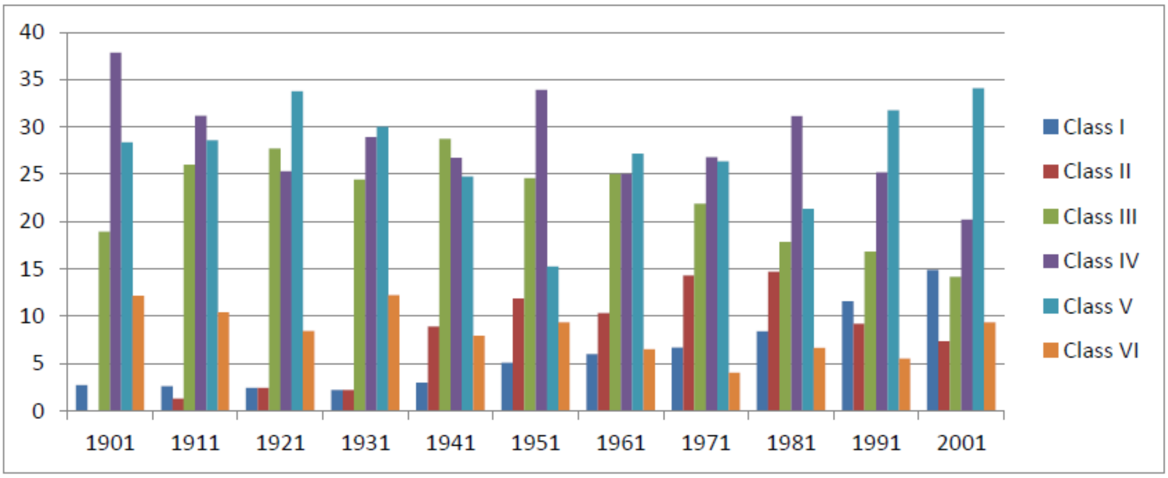


Figure 4. 16 : West Bengal: Urban Population Proportion 1901-2001
Source: Census Report of India for relevant years

The high density of urban population in West Bengal, which was recorded in Census 2001 at around 6798 people per square kilometre, is another important feature of urbanisation. Intriguingly, at that time, almost 28% of the urban population occupied only 2.93 percent of the state's land area, putting enormous strain on the state's urban and municipal infrastructure, services, and general quality of life (www.wburbandev.gov.in/11th Plan/6-8.pdf).

Regional Pattern of Urbanization in West Bengal

As previously stated, and as shown in Figure 4.16, the growth rate of the urban population is relatively higher in the majority of the state's "river bank" districts, indicating relatively higher prospects for economic growth and a greater concentration of developmental interventions. During the years 2001-11, districts like Malda (129 percent), South 24 Paraganas (92 percent), and Murshidabad (92 percent) experienced exceptional decennial growth in urban population, indicating a phenomenal shift in population away from rural areas and the graduation of previously relatively large villages into census/status towns. On the other hand, it's interesting to see that Kolkata, a city that's been around for over three years, has had a negative growth rate over the last decade, indicating saturation and a slowdown. Kolkata's deteriorating quality of life, coupled with mounting pressure on the city's infrastructure, has prompted a wave of emigration.

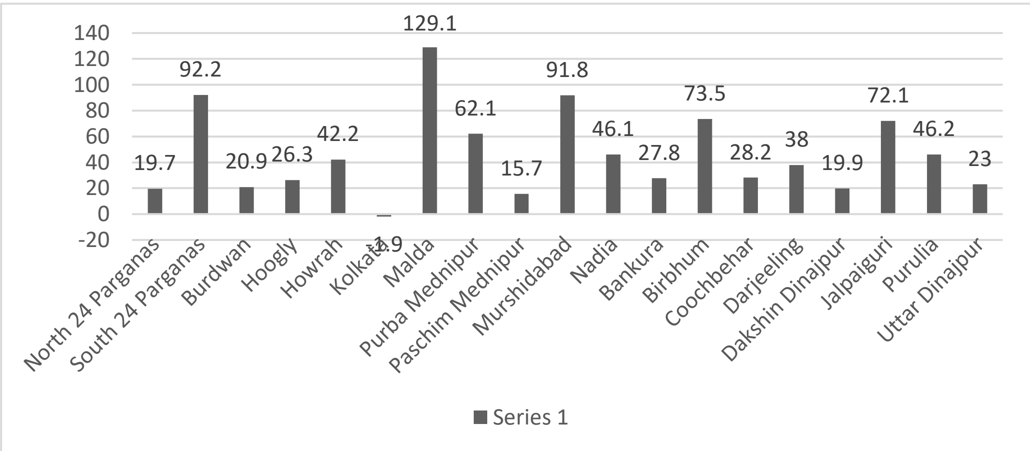


Figure 4. 17 : West Bengal: Growth rate of Urban Population 2001-2011(%)
Source: Census Report of India for relevant years

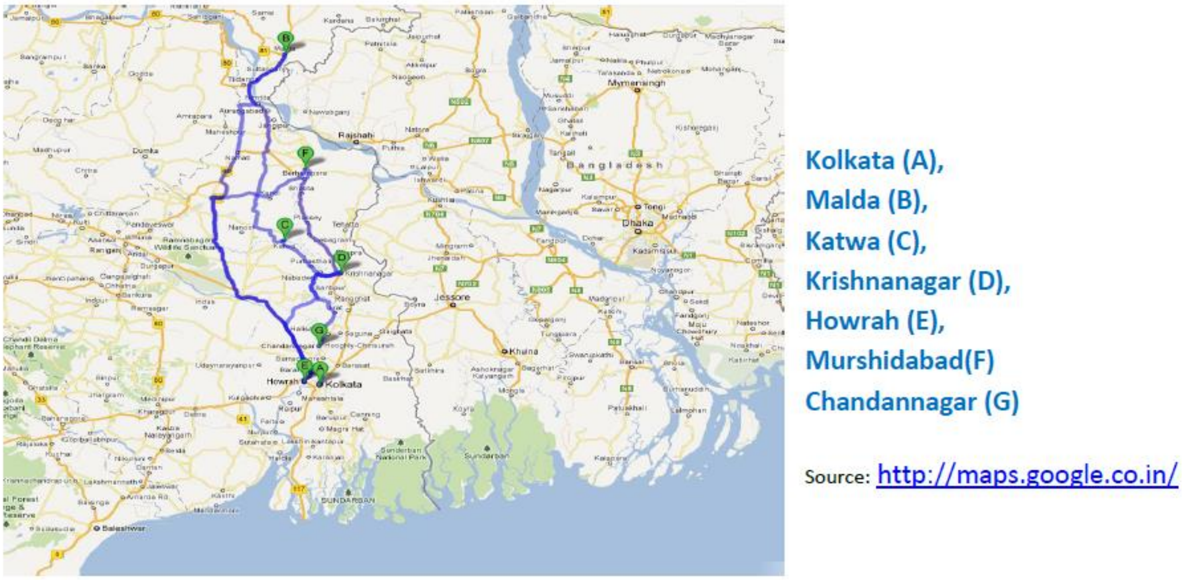


Figure 4. 18: West Bengal: Major Urban Centres along River Ganga
Source: http://maps.google.co.in

There is a strong correlation between urban population and total population in West Bengal's river bank districts, as shown in Figure 4.19. As previously stated, this shows that a significant portion of the growth in West Bengal's urban population has been driven by rapid population growth in river bank districts over the last decade.

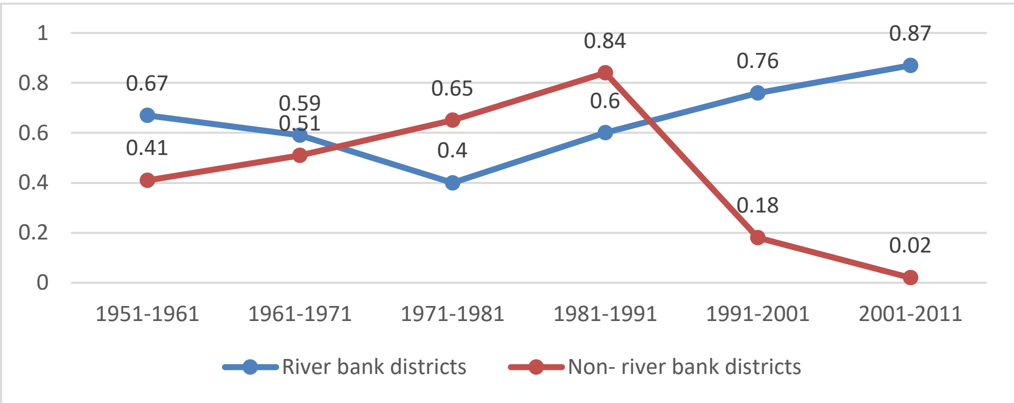


Figure 4. 19 : West Bengal: Correlation between Urban & Total population growth rate
Source: Census report of India 1981, 1991, 2001, 2011.

Figure 4.19 shows that riverbank districts have a higher density of urban residents. These include Kolkata (at 100% urbanisation), Howrah (63%), and North 24 Paraganas (58% urban population). Most of West Bengal's districts have seen an increase in the proportion of urban residents over the last decade, with river bank districts leading the way.

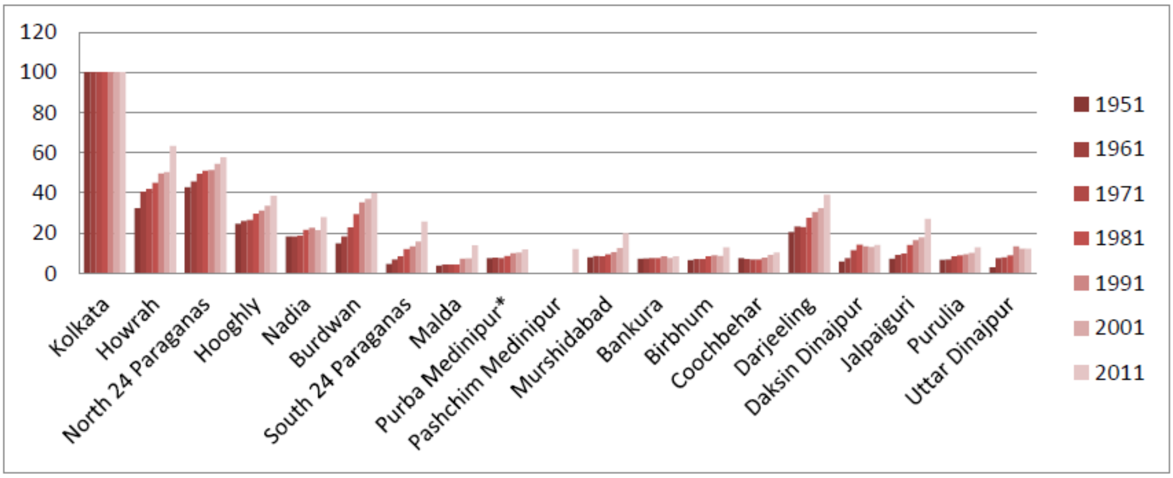


Figure 4. 20 : West Bengal: District wise percentage of urban population (1951-2011)
Source: Census report of India 1981, 1991, 2001, 2011.

As shown in Figure 4.21, the highest population density is found in Baranagar, followed by South Dumdum, Kamarhati, and Kolkata, all of which have populations exceeding 24,000 people per square kilometre. They are all part of the Kolkata Metropolitan Area, while the first three are in North 24 Parganas, demonstrating the district's level of urbanisation.

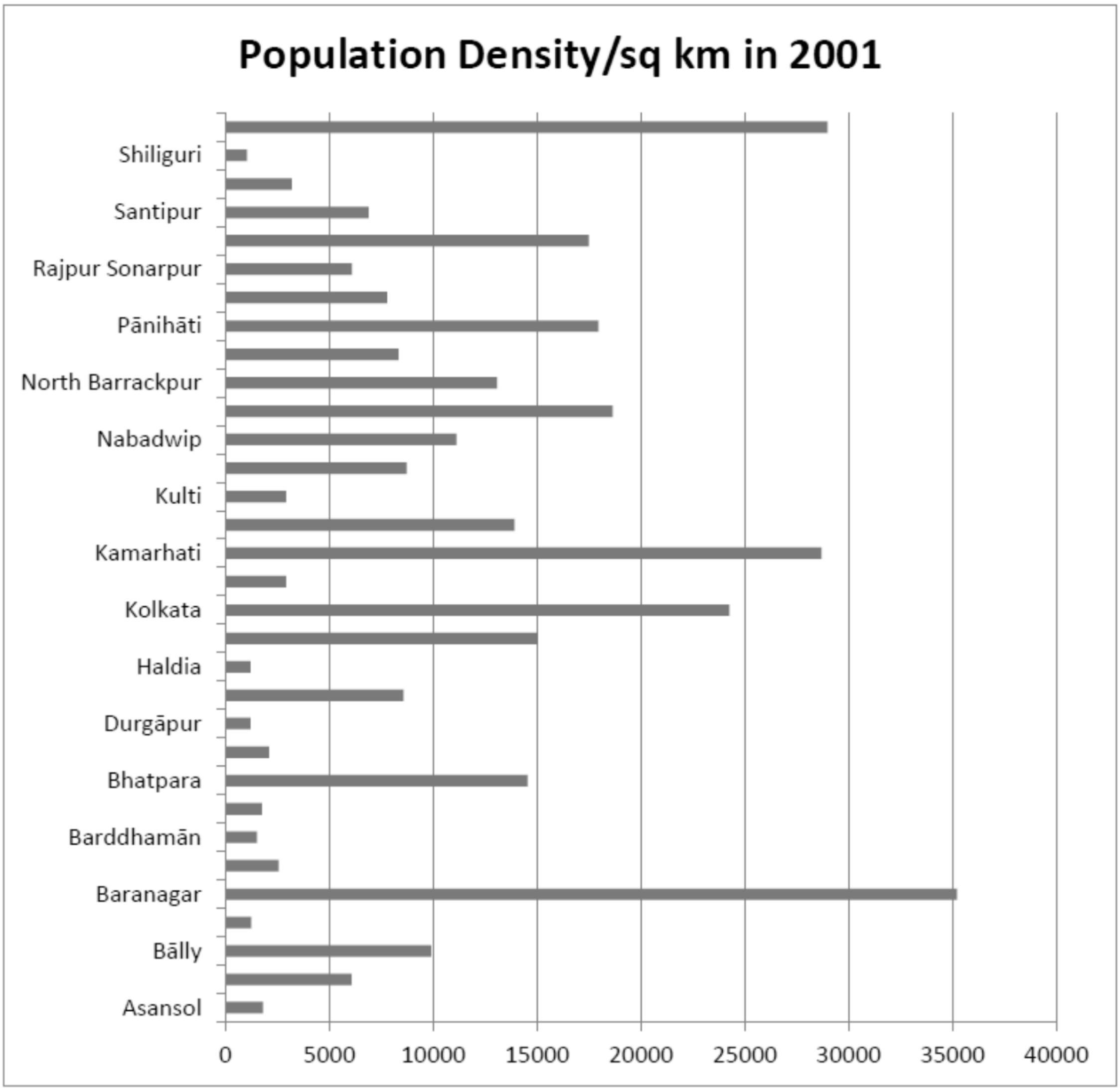


Figure 4. 21: West Bengal- Density of population in Urban Centres (2001)
Source: Census report of India 2001.

Table 4.7 further classifies districts based on the size of the urban population and the rate of growth of the urban population, revealing just how urbanised each district has become. While some districts have moved from establishing an urbanisation trend to becoming urbanised, it's clear that some districts have remained rural over time. According to the Census 2011, on average, all nine "non-river bank" districts are rural, while up to five out of ten "river bank" districts are either classified as urbanised or have established a strong trend towards urbanisation. Districts like Kolkata, Howrah, and North 24 Paraganas are already urbanised, while Hooghly and Burdwan are on the cusp of urbanisation. It's interesting to note that Malda, despite having the highest decennial urban population growth rate, is still classified as a rural district.

Table 4. 7 : West Bengal: District-wise Urbanisation scenario

Districts	1951	1961	1971	1981	1991	2001	2011
River Bank District							
North 24 Paarganas	Urbanization trend	Urbanization trend	Urbanization trend	Urbanized	Urbanized	Urbanized	Urbanized
South 24 Paraganas	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Burdwan	Still Rural	Still Rural	Still Rural	Still Rural	Urbanization trend	Urbanization trend	Urbanization trend
Hooghly	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Urbanization trend	Urbanization trend
Howrah	Still Rural	Urbanization trend	Urbanization trend	Urbanization trend	Urbanization trend	Urbanized	Urbanized
Kolkata	Urbanized	Urbanized	Urbanized	Urbanized	Urbanized	Urbanized	Urbanized
Malda	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Midnapore (undivided)	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Murshidabad	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Nadia	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Non River Bank District							
Bankura	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Birbhum	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Coochbehar	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Darjeeling	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Daksin Dinajpur	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Jalpaiguri	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Purulia	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
Uttar Dinajpur	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural
West Bengal	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural	Still Rural

Source: Magnitude inferred from table 4.6(Census report of India 1981, 1991, 2001, 2011, Government of West Bengal)

4.3 Delineation/ selection of area for sample study, *Identifying the study area in West Bengal*

In the years 2001–2011, new Census Towns accounted for nearly 70% of West Bengal's urban growth, and the total number of Census Towns in the state reached 780. Census Towns typically have a population of around 10,000 residents. There are only 16 cities with populations greater than 30,000 people. Nevertheless, the Main Map (Figure 4.22) reveals that some of these census towns spatially amalgamate, resulting in urbanising clusters that are significantly larger than the census suggests. Because population counting stops at the fixed administrative boundary of each distinct settlement, this clustering goes unnoticed (Duijne, Choithani, & Pfeffer, 2020) .

New Census Towns tended to appear within a 10-kilometer radius of existing Census Towns, according to the data (66%). Cities appear to serve as critical nodes in rural areas, igniting a long-term process of urban expansion spurred on by the loss of farm jobs. Statutory Towns (i.e. the more well-established cities) also appear to play an important role in the emergence of Census Towns. Many new Census Towns spring up in the suburbs and peri-urban areas around established cities, fuelling suburban/peri-urban Census Town growth (Guin & Das, 2015), 2015b; Van Duijne & Nijman, 2019 (Van & Nijman, 2019). The relationship between Census Towns and Statutory Towns has yet to be thoroughly studied, as previously mentioned. Non-farm livelihoods aside, it's reasonable to assume that many people in the new urban areas commute to nearby larger cities on a regular basis. The implication of this hypothesis is that in some Census Towns, the shift to nonfarm work is not taking place locally, but that new 'urban' livelihoods can be found elsewhere.

Over half of all Census Towns were founded within a 50-mile radius of Kolkata, and the districts of Haora, Hugli, and South 24-Parganas (shown on the Main Map) all experienced rapid growth in the number of Census Towns. The rapid expansion of unorganised and informal manufacturing activities in and around the Kolkata agglomeration is most likely to blame for this increase. According to research, many small businesses now provide nonfarm employment opportunities in formerly agrarian areas surrounding the megacity (Chattaraj, 2015) (Khasnabis, 2008) (Sarkar A. , 2006)

A total of 365 Census Towns (47%) were found to be at least 50 km away from Kolkata. Even the most remote northern West Bengal districts, such as Maldah, Dinajpur, Darjeeling, Jalpaiguri, Koch Bihar, and Alipurduar, have 85 new Census Towns. A shift away from farming as a primary source of income is required as a result of this urbanisation in the state's outlying rural regions.

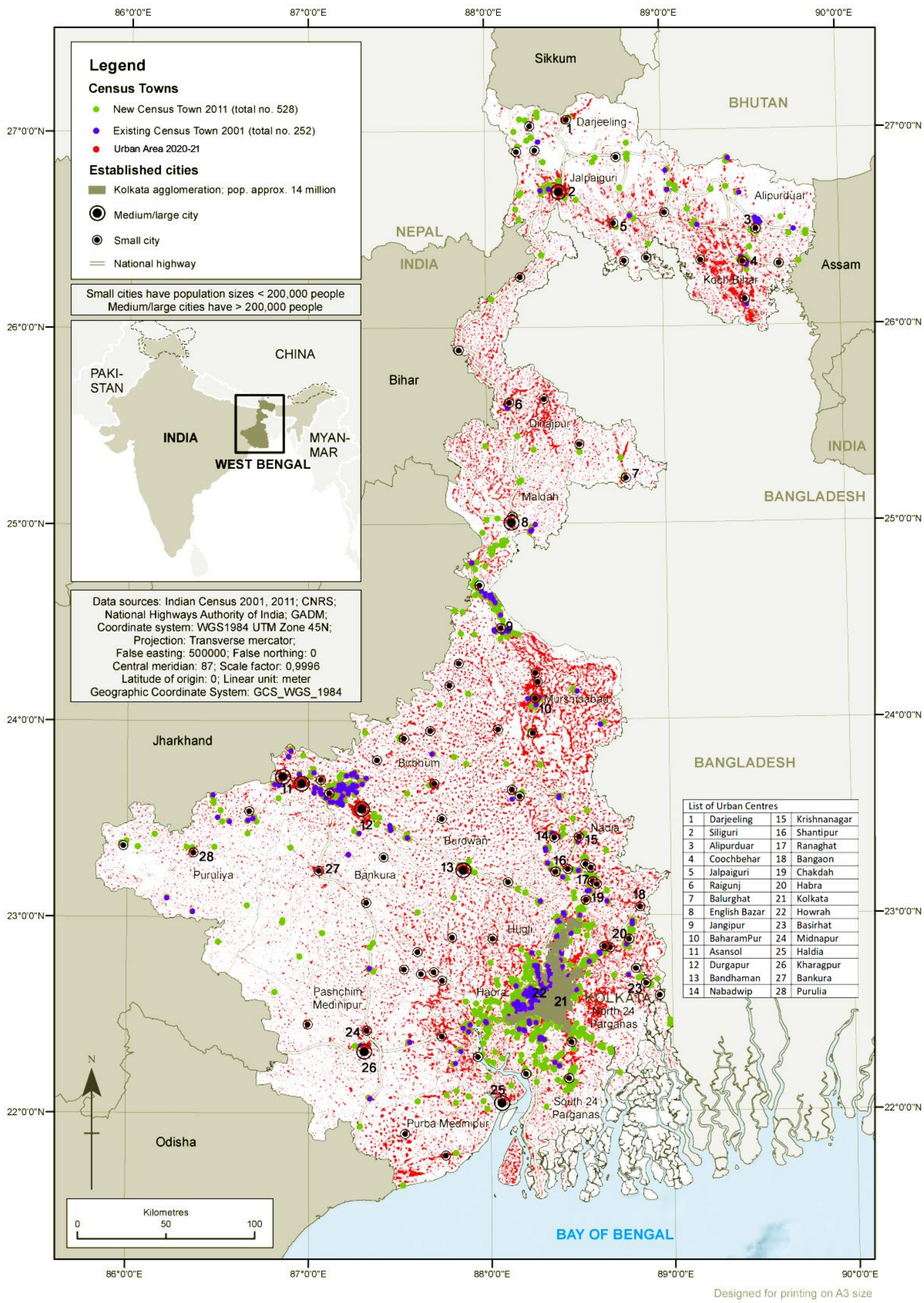


Figure 4. 22 : West Bengal: Urban centre/Urbanisation frequency mapping 2001, 2011, 2021)
Source: Census report of India 2001, 2011 & GIS mapping of 2021 growth patten by author.

These districts have a reputation for being flood and drought prone (P. P. Bhattacharya, 2016); (Ghosh, 2016), resulting in frequent crop failures and strain on already precarious livelihoods and living conditions. Half of these districts are supported by India's national emergency Backward Regions Grant Fund (BRGF) (Ministry of Panchayati Raj, Government of India, 2011). Finally, and this is particularly relevant to the rest of the paper, infrastructure corridors appear to play an important role in the emergence of Census Towns, with 118 of them being located within 3 kilometres of a national highway. New Census Towns have appeared in the middle of the main map, creating what has been dubbed "emergent highway urbanisation" (Balakrishnan, 2013); (Van & Nijman, 2019). In the coming years, India's plans to construct an additional 84,000 kilometres of highway as part of the Bharatmala Pariyojana Scheme will likely take on a more significant hue (India, Bharatmala Pariyojana. A stepping stone towards ‘New India’. Ministry of Road Transport & Highways, Government of India., 2017) (India, Agriculture census 2015–2016, 2018); (Sural, 2018) (Sood, 2018). It was discovered that West Bengal's decadal urban population growth was significantly lower than that of India's other developed states. According to the 2011 census, West Bengal's urban population totalled 290,93,002 people, up slightly from the 2001 census's 27.9 percent to the 2011 census' 31.8 percent (Sarkar A. , 2006). The rate of urbanisation in West Bengal hasn't increased significantly over time (Chattopadhay & Mukhopadhay, 1996). However, in some districts, such as Howrah, Hugli, Darjeeling, Jalpaiguri, and the South 24 Parganas, the increase is significant. Following Kolkata, Howrah, North 24 Parganas, and Bardhaman were the most urbanised districts in 2011. According to the annual growth rate of the urban population, growth in the most urbanised districts has been low, while growth in the less urbanised districts of the state has been remarkable. This is an important finding. It is noteworthy that the districts of South 24 Parganas and Jalpaiguri confirm the highest percentage increase in urban population between 2001 and 2011.

	Districts	**2001**	**2011**	**Changes**
1	Bankura	7.37	8.36	+0.99
2	Bardhaman	36.94	39.87	+2.93
3	Birbhum	8.57	12.8	+4.23
4	Cooch Bihar	9.1	10.25	+1.15
5	Dakshin Dinajpur	13.1	14.13	+1.03
6	Darjeeling	32.34	38.99	+6.65
7	Howrah	50.36	63.6	+13.24
8	Hugli	33.47	38.62	+5.15
9	Jalpaiguri	17.84	27.0	+9.16
10	Kolkata	100	100	0
11	Malda	7.32	13.8	+6.48
12	Murshidabad	12.49	19.78	+7.29
13	Nadia	21.27	27.81	+6.54
14	North 24 Parganas	54.3	57.59	+3.29
15	Paschim Medinipur	11.9	12.03	+0.13
16	Purba Medinipur	8.29	11.65	+3.36
17	Purulia	10.07	12.75	+2.68
18	South 24 Parganas	15.73	25.61	+9.88
19	Uttar Dinajpur	12.06	13.8	+1.74
20	West Bengal	27.9	31.8	+3.9

Table 4. 8: West Bengal: District-wise degree of Urbanisation scenario 2001 & 2011
Source: Calculation using Census of India 2001 and 2011.

Pattern of urbanization of West Bengal:

In 2011, the urbanisation levels of West Bengal's 19 districts divided the state into three broad categories.

"*Large Scale Urbanisation (More than 30 per cent*)": The most densely populated districts are found in the six districts with urbanisation rates greater than 30%. The high level of urbanisation was found in the districts of Kolkata, Howrah, and North 24 Parganas Bardhaman, Darjeeling, and Hugli due to the level of industrial development, their strategic location along well-developed roads and railway lines, and high social development due to high male and female literacy rates, among other factors.

"Medium Scale Urbanisation (15-30 per cent": This group consists of the four districts with urbanisation rates ranging from 15 to 30 percent. Nadia, Jalpaiguri, South 24 Parganas, and Murshidabad all have a medium level of urbanisation. Due to the effects of urban shadow, migration from city to city, the moderate level of industrial development, and location along major transportation routes, there was a medium level of urbanisation.

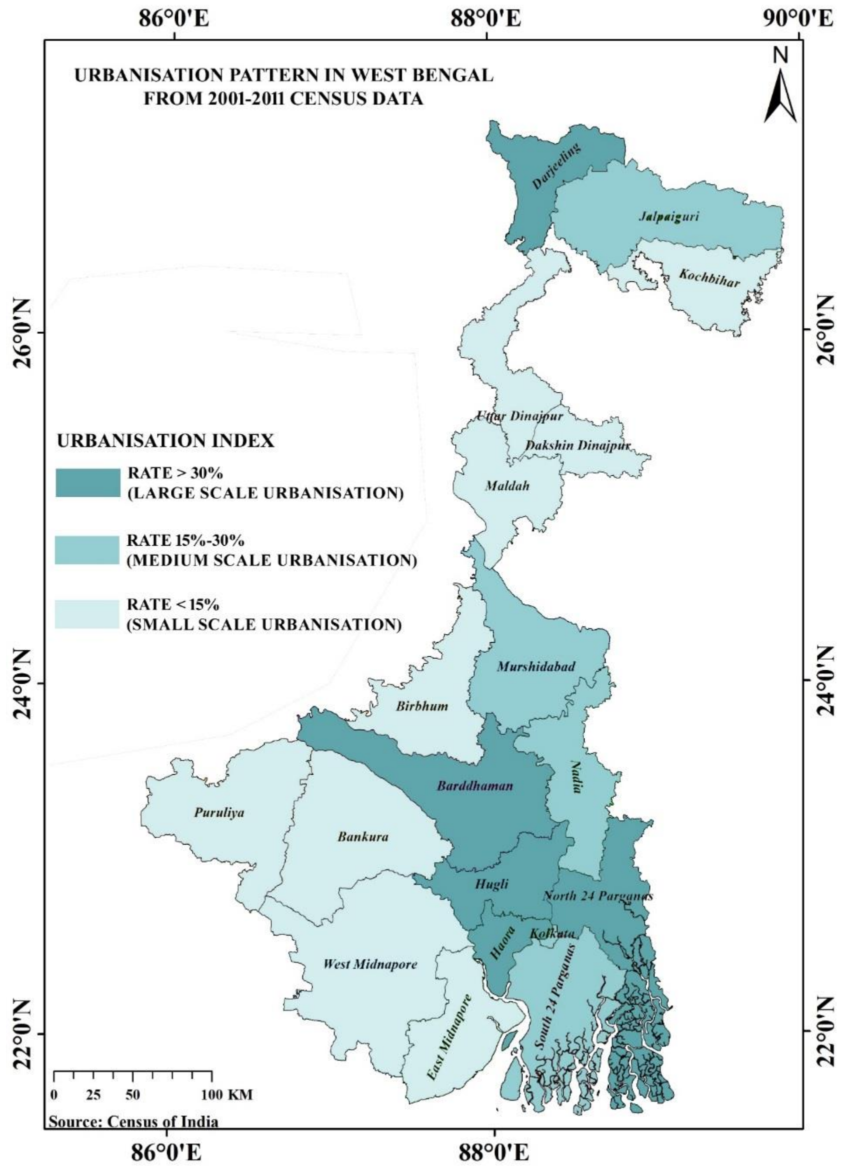


Figure 4. 23 : West Bengal: Urbanisation pattern mapping 2001, 2011, 2021)
Source: Census report of India 2001, 2011 & GIS mapping of 2021 growth patten by author.

"Small Scale Urbanization (Less than 15 per cent)": Districts with an urbanisation rate of less than 15% are classified as "low". South Dinajpur district has the lowest rate of urbanisation followed by Birbhum and Malda. East and West Mednipur districts have the highest rates of urbanisation. The low rate of urbanisation in the districts is due to a number of factors, including a lack of agricultural and industrial development, socio-cultural backwardness, a lack of diversification, low literacy, and few job opportunities.

Table 4. 9 :Measurement of concentration of urban population at district level in West Bengal, 2011

Districts	**Total area km sq.**	**Urban area km sq.**	**Urban area % of total (x)**	**Population as % of total (y)**	**(x)-(y)**	**x-y/2**	**Urban population**
	(1)	***(2)***	***(3)***	***(4)***	***(5)***	***(6)***	***(6)***
Bankura	6882	90.5	1.32	1.03	0.28	0.14	2,99,773
Bardhaman	7024	933.7	13.29	10.58	2.71	1.36	30,78,299
Birbhum	4545	120.4	2.65	1.54	1.10	0.55	4,49,448
Kolkata	185	185	100.00	15.46	84.54	42.27	44,96,694
Darjeeling	3149	153.5	4.87	2.50	2.37	1.19	7,27,963
Howrah	1467	431.1	29.39	10.57	18.82	9.41	30,74,144
Hugli	3149	328.4	10.43	7.32	3.11	1.56	21,28,499
Jalpaiguri	6227	367.3	5.90	3.64	2.25	1.13	10,60,351
Kooch Bihar	3387	68.9	2.03	0.99	1.04	0.52	2,89,434
Malda	3733	86.1	2.31	1.86	0.44	0.22	5,41,660
Murshidabad	5324	275.9	5.18	4.81	0.37	0.18	14,00,692
Nadia	3927	314.9	8.02	4.95	3.07	1.54	14,38,873
North 24 Parganas	4094	623.9	15.24	19.70	-4.46	-2.23	57,32,162
Purulia	6259	147.5	2.36	1.28	1.07	0.54	3,73,314
South 24 Parganas	9960	418.7	4.20	7.18	-2.97	-1.49	20,87,773
Uttar Dinajpur	3140	64.7	2.06	1.25	0.82	0.41	3,62,228
Dakshin Dinajpur	2219	31.3	1.41	0.81	0.60	0.30	2,36,295
Paschim Medinipur	9368	253.3	2.70	2.48	0.22	0.11	7,22,686
Purba Medinipur	4713	224.3	4.76	2.04	2.72	1.36	5,92,714
West Bengal N=	**88752**	**3324.75**	**100**	**100**	**132.96**	**66.48**	**290,93,002**

Source: Author's Calculation using Census of India 2011

Measurement of concentration of urban population in West Bengal: Across West Bengal, urban population distribution is fairly uneven. In fact, this is a crucial aspect of Indian urbanisation (Singh, 1978). Let's take a look at the disparity in urbanisation by using one of the most straightforward methods for determining the density of the urban population at the district level. Both the population and the land area are clearly not distributed equally among the districts. The percentage of a district's total population has no bearing on the percentage of the district's total land area under its jurisdiction. The disparity between the district's share of the total area reflects urban population distribution that is uneven (see column 5 in Table 4.9).

Unequal growth of cities in state of West Bengal: West Bengal is a state in eastern India with a total area of 34,267 square miles. It ranks as India's 4th most populous state. With a population of 91 million people, West Bengal is the most densely populated state in India. Of these, 29 million people live in urban areas, with a 2011 urban population share of 31.89 percent. The state also has the highest population density in the country at 6,789 people per square kilometre. Coming out of a large number of census towns (CTs) and contributing to the growth of the urban population changed urbanisation significantly in West Bengal. According to the 2011 census, West Bengal is the top state by far, with 782 census towns compared to 252 in 2001. For the first time in 2011, census town (CT) growth jumped to a record high of 209.52%, according to the findings (Figure 4.22).

Since independence, West Bengal's urbanisation has been concentrated in and around the state's industrial metropolises of Kolkata, Durgapur, and Asansol. This pattern has begun to change with new urban growth outside the metropolitan area, which can be described as'subaltern urbanisation' (Denis, Mukhopadhyay, & Zerah, 2012). Existing research on the broad pattern of urban size distribution in West Bengal during the twentieth century shows that the state's largest city is a large metropolitan area. Between 1971 and 2001, the urban population of West Bengal was accounted for 64 to 58 percent by the Kolkata Metropolitan Area (KMA). Kolkata Urban Agglomeration (KUA) and the surrounding region can be clarified by defining as the three different regions (i) Urban agglomerations distributed throughout West Bengal (ii) Urban agglomerations in Kolkata (iii) and individual cities and towns. Their personalities and growth and development processes differ in each of these three regions, making them unique. Calcutta, also known as Kolkata, is a large urban agglomeration in India, home to nearly half (48.44 percent) of the state's urban population. The urban agglomerations of Asansol (4.27 percent) and Siliguri (2.14%) and Durgapur (2%), respectively, accounted for 2.14 percent and 2 percent of total urban population in 2011. The cities in this state more or less are in the form of primate cities with uneven growth of lower order urban centres. With regard to population density, this graph shows how densely populated cities are in relation to each other. After plotting data on a logarithmic scale, it was discovered that the actual population and the excepted population have a linear relationship. On the basis of the Indian census, this paper attempts to draw attention to the nature, pattern, and magnitude of uneven urbanisation in West Bengal. The results show that this state has a very low level of urbanisation; however, urbanisation increased slightly from 27.9% in the 2001 Census to 31.8 percent in the 2011 Census. West Bengal has, in fact, experienced slightly faster urbanisation than the national average. For the first time in 2011, census town (CT) growth jumped to a record high of 29.52%, according to the findings. In West Bengal, the distribution of the urban population is quite unequal. The disparity between the district's share of the total area reflects the city's uneven population distribution.

4.4 Rank Size rule vs Primacy

4.4.1 Rank Size rule application to locate major Urban centre

Table 4. 10 : Rank-size distribution of top five cities in West Bengal, 2011

Name of the town	Population (Pr)	Log (Pr)	Log (r)	Log $(r)^2$	Log (Pr)*Log (r)	Expected population $Pr = P_1 (r)b$	Deviation of actual population from the expected population
Kolkata (1)	4496694	6.653	0.000	0.000	0.000	4271254	225440
Howrah (2)	1077075	6.032	0.301	0.091	1.816	2098622	-1021547
Durgapur (3)	566517	5.753	0.477	0.228	2.745	1419843	-853326
Asansol (4)	563917	5.751	0.602	0.362	3.463	1064115	-500198
Siliguri (5)	513264	5.71	0.699	0.489	3.991	850791	-337527

Source: Author's Calculation using Census of India 2011

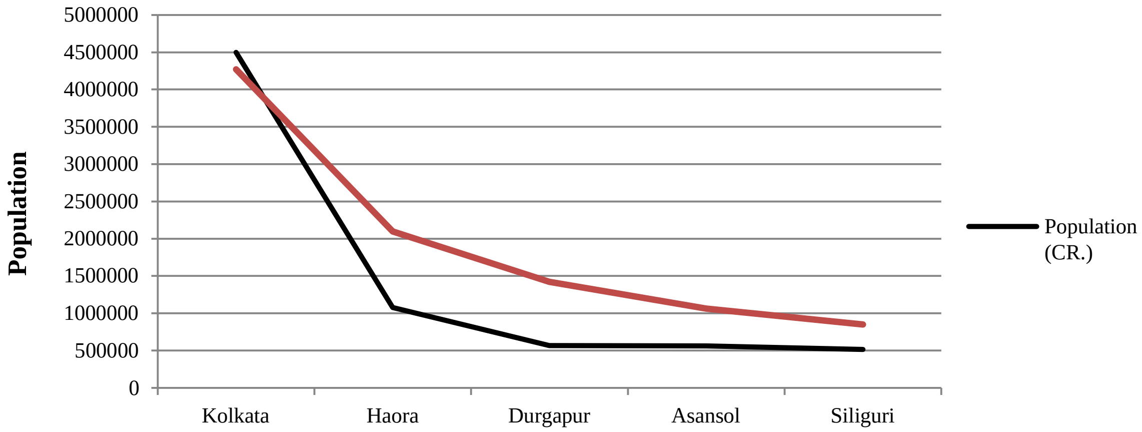


Figure 4. 24: Rank size distribution of selected urban centres in West Bengal, 2011
Source: Author's Calculation using Census of India 2011

From the rank size rules table, it is evident that ***Kolkata*** is the topmost metropolis amongst all other urban sprawls in West Bengal taken into consideration.

4.4.2 Primacy Index calculation in West Bengal to find out area with major urbanisation

Table 4. 11:Urban population in 1951 census

Rank	City	Population
1	Kolkata	44,46,000
2	Bhardhaman	3,08,284
3	Asansol	91,000
4	Siliguri	32,400
5	Maldah	15,885

Source- Population Census India 1951

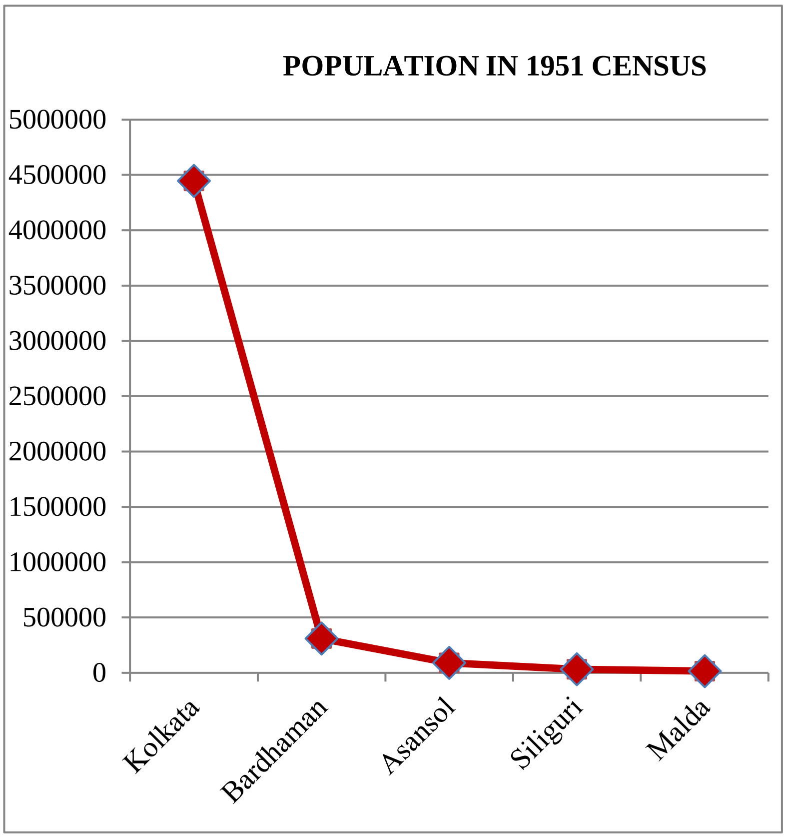
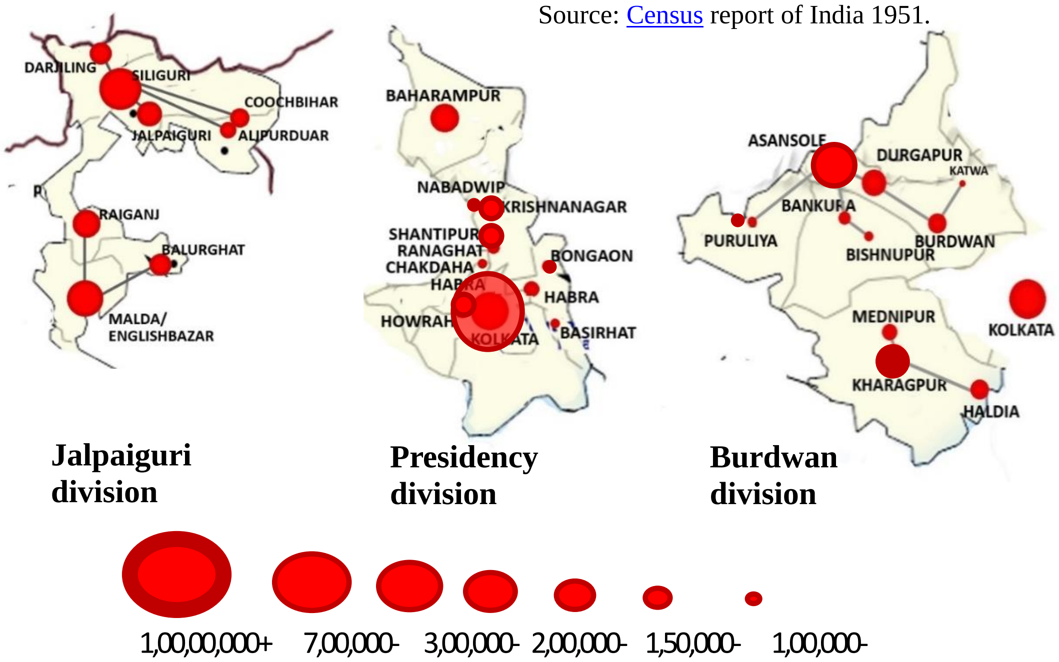


Figure 4. 25 : West Bengal: City size distribution 1951
Source: Census report of India 1951.

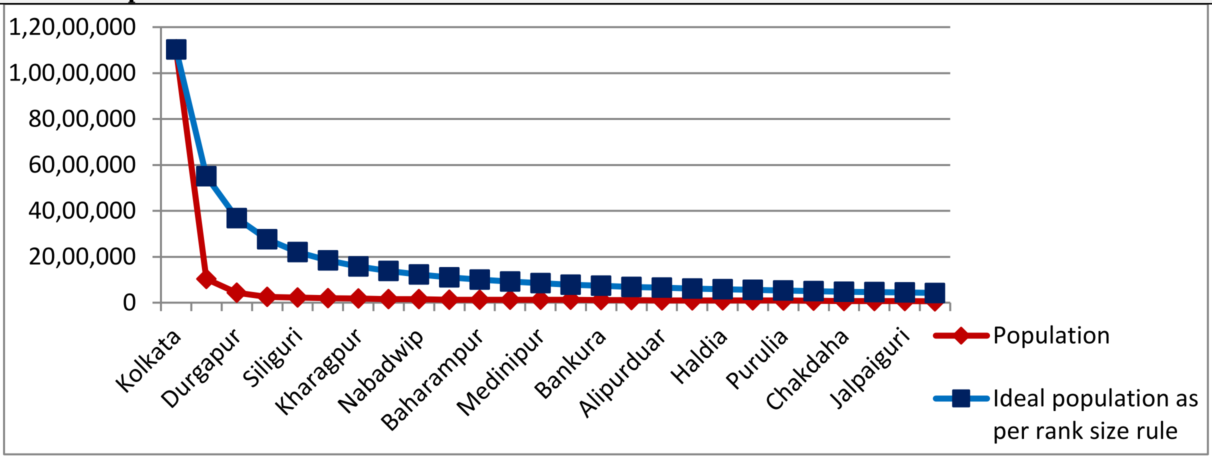


City size distribution at different divisions in West Bengal

Table 4. 12: Urban population in 1991 census

Rank	City	Population	Distance from Kolkata (km)	Rank	City	Population	Distance from Kolkata (km)
1	Kolkata	43,99,819		15	Bankura	1,14,876	173
2	Asansol	10,26,127	224	16	Shantipur	1,09,956	75
3	Durgapur	4,25,836	160	17	Alipurduar	1,02,815	727.5
4	Bhardhaman	2,45,079	120	18	Basirhat	1,01,409	66.5
5	Siliguri	2,16,950	606.9	19	Haldia	1,00,347	125
6	Habra	1,96,970	50	20	Coochbehar	92,820	769
7	Kharagpur	177989	127.6	21	Purulia	92,386	287
8	Raigunj	1,59,266	426	22	Bangaon	79,571	75.9
9	Nabadwip	1,55,905	119	23	Chakdah	74,769	67.8
10	Ranaghat	1,27,035	77.4	24	Darjeeling	73,062	659.8
11	Baharampur	1,26,400	200	25	Jalpaiguri	68,732	600.5
12	Balurghat	1,26,225	433	26	Dhulian	62,242	277.3
13	Medinipur	1,25,498	127	27	Jangipur	55,981	268
14	Krishnanagar	1,21,110	100	-	-	-	-

Source- Population Census India 1991



Primacy index= 11021918/(11021918+1026127+425836+245079+216950) = 0.85>0.5

Figure 4. 26 : West Bengal: City size distribution 1991
Source: Census report of India 1991.

Table 4. 13: Urban population in 2011 census

Rank	**City**	**Population**	**Distance from Kolkata (km)**	**Rank**	**City**	**Population**	**Distance from Kolkata (km)**
1	Kolkata	1,41,12,536		16	Krishnanagar	1,81,182	100
2	Asansol	12,43,008	224	17	Nabadwip	1,75,474	119
3	Siliguri	7,01,489	606.9	18	Medinipur	1,69,127	127
4	Durgapur	5,81,409	160	19	Jalpaiguri	1,69,013	600.5
5	Kharagpur	3,72,339	127.6	20	Balurghat	1,64,593	433
6	English Bazar	3,24,237	347	21	Basirhat	1,44,891	66.5
7	Baharampur	3,05,609	200	22	Bankura	1,38,036	173
8	Habra	3,04,584	50	23	Chakdaha	1,32,855	67.8
9	Bardhaman	3,47,016	120	24	Darjeeling	1,32,016	659.8
10	Shantipur	2,88,718	75	25	Alipurduar	1,27,342	727.5
11	Dankuni	2,49,840	15	26	Purulia	1,26,894	287
12	Dhulian	2,39,022	277.3	27	Jangipur	1,22,875	268
13	Ranaghat	2,35,583	77.4	28	Bangaon	1,10,668	75.9
14	Haldia	2,00,762	125	29	Cooch Behar	1,06,760	769
15	Raiganj	1,99,758	426				
Source- Population Census India 2011							

Actual city size Kolkata
Ideal city size according to Rank size Rule

Primacy index= 14112536/(14112536+1243008+701489+581409) = 0.8 >0.5

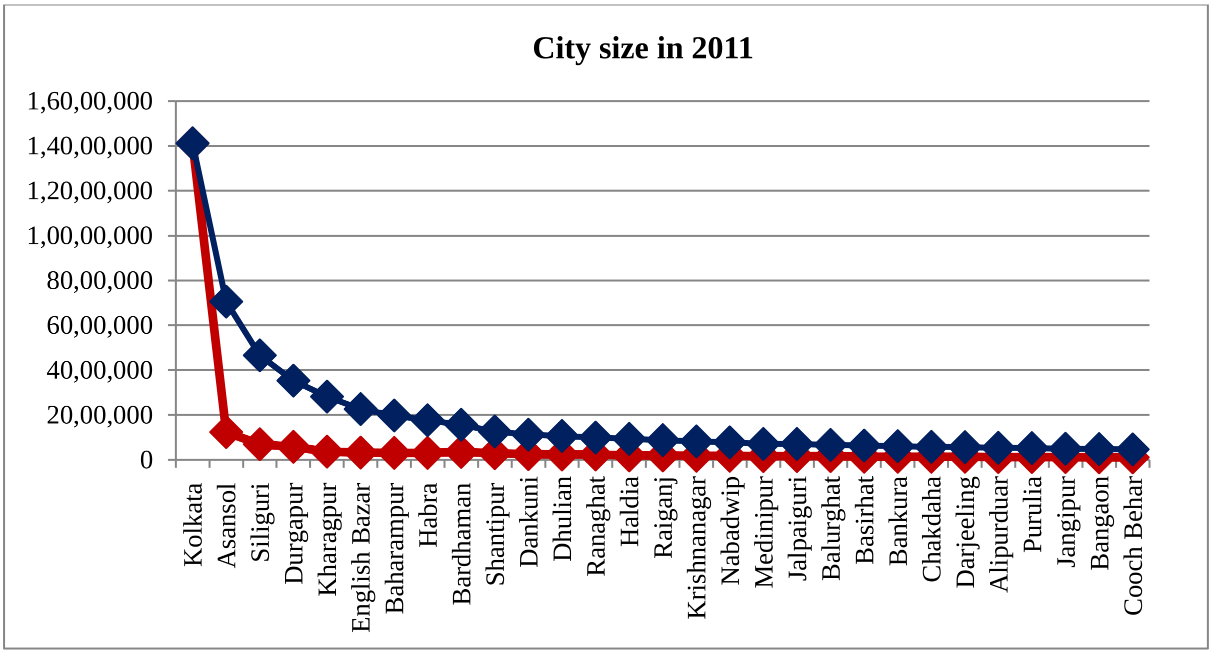


Figure 4. 27 .: West Bengal: City size distribution 2011
Source: Census report of India 2011.

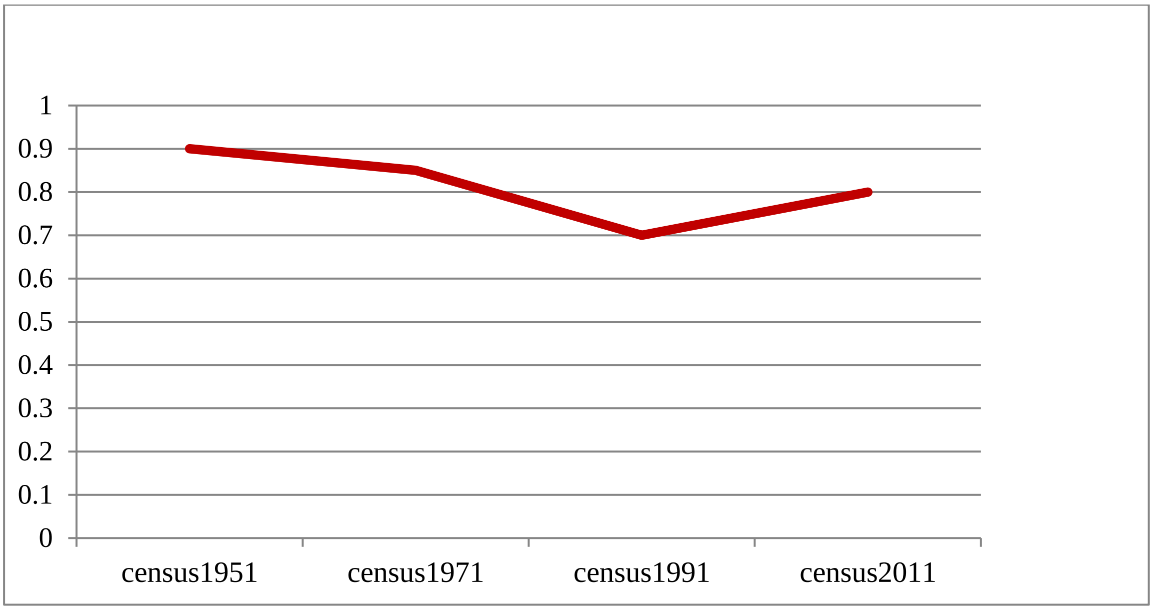


Figure 4. 28 : Primacy index of Kolkata with respect to West Bengal.
Source: Census report of India 2011.

It can be concluded from the graph that if the cities with more than 1 lakh population are considered, then **KOLKATA** definitely comes out to be the primate city of West Bengal.

4.5 Selection of KMA as the study area Singh, J. (surrounding the City of Kolkata)

Kolkata is West Bengal's primate city, based on the conclusions drawn above. Because of its illustrious past and promising future, Kolkata has become a primate city for the entire region of North East India. The British colonial rulers of India used Kolkata as a port city to transport goods between the Indian colonies and the Western world. As a Presidency city, Calcutta was developed in 1699 by the East India Company of Great Britain. Calcutta served as the British Indian Empire's capital from 1858 until 1911. And began to experience rapid industrial growth in the early 1850s, especially in the textile and jute industries. Since the 18th century, Kolkata has been the cultural and educational hub of Bengal. This market city became the colonial metropolis after serving as the economic and political hub of British power. West Bengal's capital was established later, following independence.

The Kolkata Metropolitan Area is now the largest in eastern India, the second largest in India, and the world's 10th largest metropolitan area. In 1912, the British shifted India's capital from Kolkata to Delhi, and the KMA became the city's metropolitan government. Kolkata's economic, political, and cultural weight has soared over the years. KMA, the city, is India's oldest metropolis at more than 300 years old. Given its age and size, Mumbai faces an unprecedented number of issues and challenges for a city its size. It is the metropolis that has pioneering experience in urban planning dating back to the early 1960s when the Calcutta Metropolitan Planning Organization (CMPO) worked with the Ford Foundation on a comprehensive planning exercise for Kolkata. The Basic Development Plan, 1966-1986, as well as the Traffic and Transportation Master Plan and the Water Supply, Sewerage and Drainage Master Plan, were the results of this pioneering effort by a group of multidisciplinary professionals. These strategies have always served as a guide for future planning efforts.

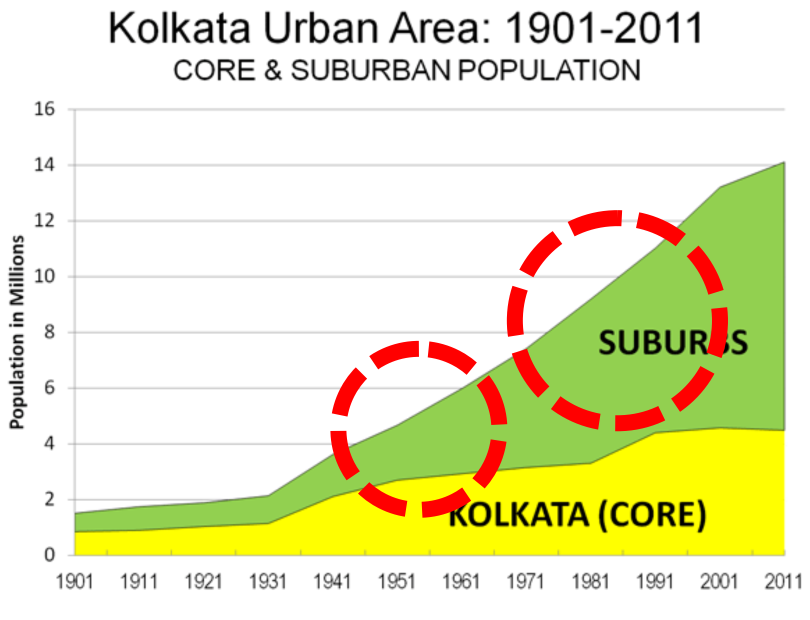


Figure 4. 29 : Kolkata core and sub-urban population.
Source: Census report of India 1901-2011.

The importance of this vision document is underscored by the fact that the state's non-agricultural sectors, particularly the service sector industries, are expanding rapidly. The West Bengal State

Development Program (SDP) has grown at the fastest rate among India's industrially advanced states in recent years, with an average annual SDP growth rate of around 7%. The tertiary sector's SDP growth rate is considerably higher. Kolkata, as a metropolis, plays a critical role in encouraging economic growth and thereby realizing the region's full potential. The competitive edge of West Bengal, particularly Kolkata, has already been revealed in the IT&ITES sector. Because the Kolkata Metropolitan Area (KMA) is surrounded by fertile agricultural hinterland, food manufacturing is another industry with a lot of promise. To realize the State's or KMA's economic growth potential, however, substantial infrastructure assistance is required. As a result, a number of studies have been prepared by international consultants that emphasize this topic. Vision values this contribution in terms of establishing and preserving a healthy living environment for KMA's projected population, as well as promoting growth outside of KMA. A prerequisite is the deployment of diverse infrastructure and services. This has been taken into account in sectoral master plans and development plans, and attempts have been made to remedy it.

Urban planning and development became a prominent focus of government attention beginning with the Third Five Year Plan in 1961. The Central Government not only recognized the significance of developing comprehensive master plans for large cities, but it also gave additional cash to aid in the construction of urban infrastructure. This was during a period of rapid growth for the city of Kolkata, but it was also plagued by severe deficiencies in civic infrastructure and services. The cholera epidemic of 1958 drew the attention of both the national government and international organisations like the World Health Organization (WHO). As a result, the Calcutta Metropolitan Planning Organization (CMPO) was established in 1961 as West Bengal's first planning organisation. The CMPO 'Basic Development Plan: 1966-86' published in 1966 presented a perspective plan for the first time in India. On the heels of this came the 'Comprehensive Traffic and Transportation Plan' and the "Master Plan for Water Supply, Sewerage and Drainage". The Basic Development Plan recommended a short-term action programme for the improvement of civil infrastructures, primarily in order to stop further deterioration in public utilities and services.

The Fourth Five-Year Plan allocated funds specifically for the implementation of infrastructure development schemes in Kolkata, but these funds quickly proved insufficient when compared to the city's requirements. It was also noted that in order to coordinate the implementation of any large-scale infrastructure development programme, a separate agency had to be established. Calcutta Metropolitan Development Authority (CMDA) was established in 1970 as a co-ordinating agency to carry out the 1970 programme. It was established in 1970 under a separate statute of the same name with the primary objective of formulating development programmes, channelling funds to implementing agencies and coordinating their implementation. Within a short period of time, CMDA had established its own execution directorates, followed by a separate planning directorate. Several planning documents have been created by the Planning Directorate thus far. Development Perspective and Four-Year Program with multi-centered development strategy (1976), Perspective Plan and Action Program' (1981), and the Preferred Structure Plan' are significant examples (1983). Transportation that is part of the overall system. Another significant planning document is the 1983 CMDA System. A draught A Perspective Plan for Calcutta: 2011 was published in 1991 by the State Planning Board of West Bengal following a review of the development perspective for CMA. A succession of CMDA planning reports followed, including the 'Plan for Metropolitan Development: 1990-2015' in 1990, the 'Development Need of the Calcutta Metropolitan Area: 1992-2002' in 1992, and the 'Calcutta Megacity Program: Project Profile and Investment Plan' in 1994.In 1994, CMDA drafted the "Concept Plan for New Town at Rajarhat" for the Housing Department of the West Bengal government. In 1995, CMDA drew up a concept development plan for a new town in the Sonarpur Baruipur Region.

Concurrently, as a statutory requirement under the West Bengal Town and Country (Planning and Development) Act of 1979, the CMDA has been involved in the preparation of existing Land Use Maps and Registers (1.UMR) and Land Use and Development Control Plan (LUDCP) [retitled from Outline Development Strategy (ODP) by an Amendment in 1994]. As required by the Act, CMDA also performs development control functions in accordance with the LUDCP.

Calcutta Municipal Corporation (CMC), Calcutta Improvement Trust (CIT), and others, in addition to CMDA, had planned and designed specific projects and programs in CMA. Howrah Improvement Trust (HIT), Calcutta Metropolitan Water and Sanitation Authority (CMW&SA), Housing Board, Hooghly River Bridge Commissioners (HRBC), Transport Department, Irrigation & Waterways Department, PWD (Roads) Department of Government of West Bengal, and central government agencies such as Metro Railways, Eastern Railways, and South Eastern Railways, among others. The 'Calcutta Environmental Management Strategy and Action Plan' (CEMSAP) for the CMA was prepared in 1997 by the West Bengal Environment Department.Calcutta's name was changed to Kolkata by the State legislature in 1999, and the same change was approved by the Central Government in December 2000.

Changing Scenario

Issues, policies, and strategies have undergone qualitative transformations. Environment, urban agriculture, the use of information technology and remote sensing satellite images, heritage, and urban conservation have all gained prominence and require appropriate treatment in the planning of future projects. Make plans for Kolkata. The state government's main goals have been to make the process of urban growth and development more effective; to make urban areas more environmentally friendly; and to make urban areas, particularly the metropolitan Ko1kata, more investment friendly. The State Government has prioritised democratically decentralised urban governance structures across the state. Decentralized urban planning and development as a matter of policy and strategy has made interventions more effective through better resource allocation among alternative uses and effective people's participation. The formation of the Kolkata Metropolitan Planning Committee (KMPC), India's first of its kind, has bolstered the democratically decentralised urban planning process.

Kolkata is now a buzzing metropolis, thanks to both external and internal factors. Its significance in eastern India has always been enormous. Kolkata's hinterland extends far beyond the city limits and into the neighbouring countries of Nepal, Bangladesh, and Bhutan. The Kolkata Port and International Airport connect the city to the rest of the world. The first period of industrialisation in the country occurred in and around Kolkata, and as a result, traditional industries such as jute, chemicals, engineering, and so on were located in and around Kolkata. Kolkata is a pre-eminent position in eastern India in terms of not only manufacturing industries, but also wholesale and retail trades, owing primarily to Kolkata Port. The confluence of all of these major economic activities has given Kolkata the character of a metropolitan city, the largest in eastern India in terms of demographic, social, and economic parameters.

A number of large and important infrastructure projects, such as the Golden Quadrilateral North-South and East-West Corridor, Kolkata Logistics Hub, West Howrah Township, Rajarhat Township, Second Vivekananda Bridge, Belghoria Expressway, Kalyani DumDum Expressway, West Howrah Township, and others, are expected to have a significant direct impact on the development scene of KMA. In the context of various other factors, the importance of KMA would continue to be significant. The Government of India's Look East Policy aims to increase trade between India and other East Asian countries, particularly China, Korea, Myanmar, and Bangladesh. The strategic importance of Kolkata, along with Siliguri, in the implementation of this Policy cannot be overstated. With China being targeted as India's major trading partner, which will be facilitated by the resumption of trade via Nathula, freight traffic to Kolkata port is expected to increase significantly. Kolkata has already seen a surge in real estate and service sector industries, particularly IT and ITES. The IT&ITES industries have been growing at a rate of around 100% per year.

IT and ITES have created numerous opportunities for implementing e governance in ULBS and infrastructure management. West Bengal's comparative advantage in this area strengthens the possibilities. The ULBs have already taken a number of steps in this direction. The municipal accounting system is being completely overhauled.

Another significant departure in urban policy has been the inclusion of private sector participation in infrastructure development and management. The State Government's Infrastructure Development Policy through Public Private Partnership (PPP) has been a significant step in this direction. The PPP Policy allows the private sector to participate in the development and management of power, telecommunications, transportation (including roads, bridges, flyovers, waterways, ports, airports, water supply, drainage & sanitation, township & area development, housing & commercial complexes, recreational projects, and so on), and other infrastructure.

4.6 Inferences

Rank size rule, Primacy index, and urban population distribution in the research area show how densely populated urban areas are. After charting data on a logarithmic scale, it was discovered that the actual population and the excepted population have a linear connection. Calcutta, also known as Kolkata, is a large urban agglomeration in India, home to nearly half (48.44 percent) of the state's urban population. But there has not been an adequate dispersion of urbanisation in this state.

Hence the next chapter focuses on to analysing the characteristic and pattern of urbanisation of **Kolkata** and its metropolitan region **KMA** to find out in depth result of causes of urban sprawl into the peri-urban areas surrounding it.

5 Result and Interpretation of Objective 2 and 3

Objective II: To delineate the macro level study area with rural-urban growth & peri-urban fringe concept.

Objective III: To analyse local & external factors influencing peri-urbanisation in macro level and selection of micro level study areas for further scope of research.

5.1 Introduction

From the results and interpretation done in the conclusion of Chapter 4 The City of Kolkata with its diversified character and megalomanias existence in the entire state of West Bengal. The methodology adopted to fulfil Objective II: Kolkata and its surroundings has been assessed in two models:

- Model 1: LULC change over time using GIS Mapping
- Model 2: Delimiting urban area based on urbanisation indicators
  The outcome of both the models are closely examined to finalise the peri-urban scenario of Kolkata. Further the area has been assessed based on few socio-economical attributes like land price, road infrastructure to understand the growth dynamics of the city.
- Model 3: Finally, weightage of indicators and Composite score analysis for assessing the saturation level of peri-urban areas of Kolkata Metropolitan Area, adopted to fulfil Objective III

5.2 Model 1: LULC change over time using GIS Mapping

5.2.1 Preparation of database and relate in GIS mapping

5.2.1.1 GIS mapping

There are two categories in which the GIS data can be broadly divided into: (i) spatial and (ii) non-spatial/vector. The first includes details about the dimensional configuration, shape, size, and spatial arrangement of the feature in relation to other features, whereas the second qualifies information about various attributes such as area, distance, demography, and so on.

5.2.1.2 Preparation of Base Map

The detailed analysis for the area of Kolkata Metropolitan Area are done through maps of the study area, which have generated based on the following tools and data source:

a) Landsat & Google Earth Satellite Images.

This study has been carried out using imageries of Landsat (of three-time points, i.e., 04/06/1991, 12/05/2001, and 10/05/2011) where the Landsat 5 was used with Thematic Mapper (TM) sensor and Landsat 8 with sensor of Operational land imager (OLI) with 30 m of spatial resolution. Band used Blue, Green, Red, NIR (Near Infra-red). These Landsat datasets are obtained from the United States of Geological Survey (USGS) portal (https:// earth explorer. usgs. gov/) which are available free of cost. This study has been performed using a decadal interval. This interval has been considered because of reasonable substantial dynamics mapping of LU/LC change as portraying the urban expansion takes time, so, 10 years of intervals are suitable for carried this study (Rousta et al. 2018). ERDAS Imagine version 16 satellite image processing was used to process the data received. Google Earth Imageries of the same timeframe used for clear detection of Area beyond Kolkata Metropolitan Development Authority, Land Use detail. All these maps were digitized using Arc GIS software version 10.3.

b) SOI Survey Toppo-Sheet and Municipal Ward Map.

Detailed maps are crucial to this study because they show the physical aspects of the urbanising environment of the urban/urban-agglomeration. The OSM TOPO-sheet maps from the Survey of India (2004-2008) at the scales were 1:50,000 used. Also, open-source type online data about state, district boundary, wetland waterbodies etc. were gathered from the website of Survey of India. The maps of urban agglomeration area of Kolkata were procured from Kolkata Metropolitan Development Authority, and different Municipal/Panchayat ward level maps acquired from the respective municipalities or panchayats. All these maps were then digitised and superimposed with their respective co-ordinates on the digitised satellite imageries by GIS mapping techniques.

c) KMDA, State Highway Authority, and RITES maps and data sheets.

The Development Planning reports/vision reports database provided with a number of layers pertaining to spatial data for Kolkata Metropolitan Area. These layers contain various features such as roads, railway networks, buildings, water canals etc. It also contains cadastral information related to individual parcels of land.

d) Data from Census of India, KMDA Vision document, Municipal DDPs.

For integration of census data for Urban/ Urban Agglomeration area around Kolkata city the KMDA boundary map, and ward level maps of different Municipal areas of KMA were used along with data set from the district census hand book of Kolkata and other areas surrounding Kolkata from 1991, 2001, and 2011. Geographic Information System (GIS) is used to analyse the census data spatially.

5.2.1.3 Components of Base Map:

The Base map is formed through a series of overlays of spatial data layers as acquired from the previously stated sources in Arc-GIS 10.3.

a) Base Layer
b) Data layers

Over the Landsat 5 (TM) and Landsat 8 (OLI) satellite image of the area under USGS & Google earth satellite images several layers available in the database provided by different development authorities have been used as overlays to create the Base Map. Layers pertaining to jurisdictional boundaries/ administrative boundaries and special planning areas (under KMDA and ULBs) have been overlaid. Layers pertaining to natural features like agricultural field, forests, water bodies, open vacant land are essential overlays and have been extracted from the given data base. Further, layers pertaining to transportation networks (airport, railways and roads) and cadastral parcels is overlaid. From the database provided by all the local bodies, along with the Landsat and Google earth satellite images the following layers will be used to create the Base Map:

- Jurisdiction boundaries: Ward boundaries and other boundaries of spatial disaggregation special planning areas, Town Planning schemes implemented;
- Physical features: Street blocks, buildings, property (cadastral parcels);

- Transportation: Roads, road centrelines, rail roads, transportation infrastructure parcels, railway stations, airport boundary, highways, water based transportation facilities, BEST bus Depot/bus stations;
- Utility infrastructure: High tension lines, water pipelines (visible above ground);
- Environmentally sensitive areas: Green Open Space, agricultural field, vacant land, water bodies, wet land etc.

c) Data to be updated

Data regarding natural elements is not readily available in the data layers provided. Since water bodies sometimes alter courses over time updated data related to water bodies, such as rivers and lakes is to be obtained from the satellite image acquired. Similarly, information regarding agricultural field is to be obtained from Detail ward data which is provided by the ULB authorities. Further, updating of the available Base Map layers such as road and road centrelines will also be done based on the satellite image procured.

The Base Map prepared by the process detailed below will form the base for the Existing Land-use Map (Fig 5.1 & Fig. 5.2). For the KMDA limits the available Base Map has been obtained from the Toppo sheet of 2004-2008's where all the available layers have been digitized at the scale suitable for each area depending on their size and has been mentioned in linear scale in each of the map produced for this thesis. Therefore, the finding the positional accuracy of the Toppo data corresponds to the geo-referenced satellite image.

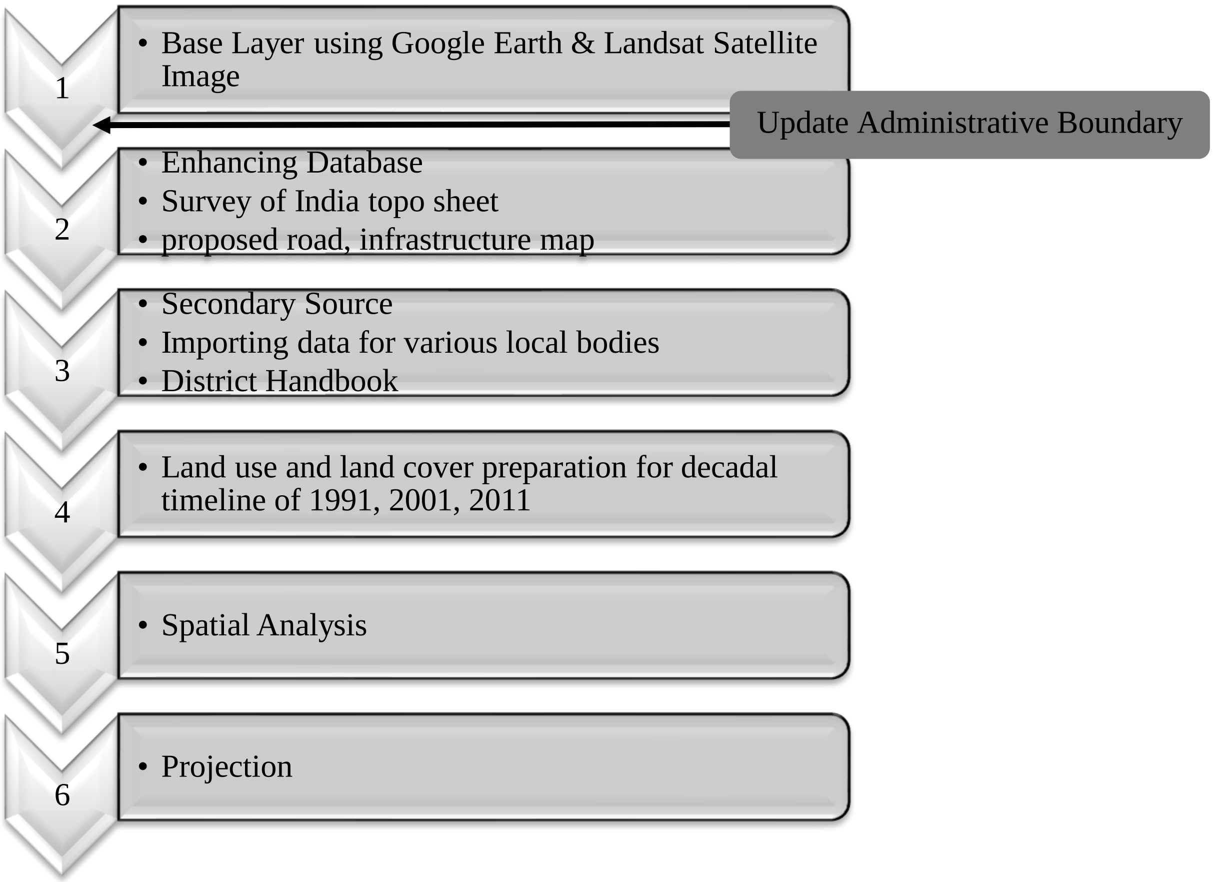


Figure 5. 1 : Base map preparation process.
Source: Author

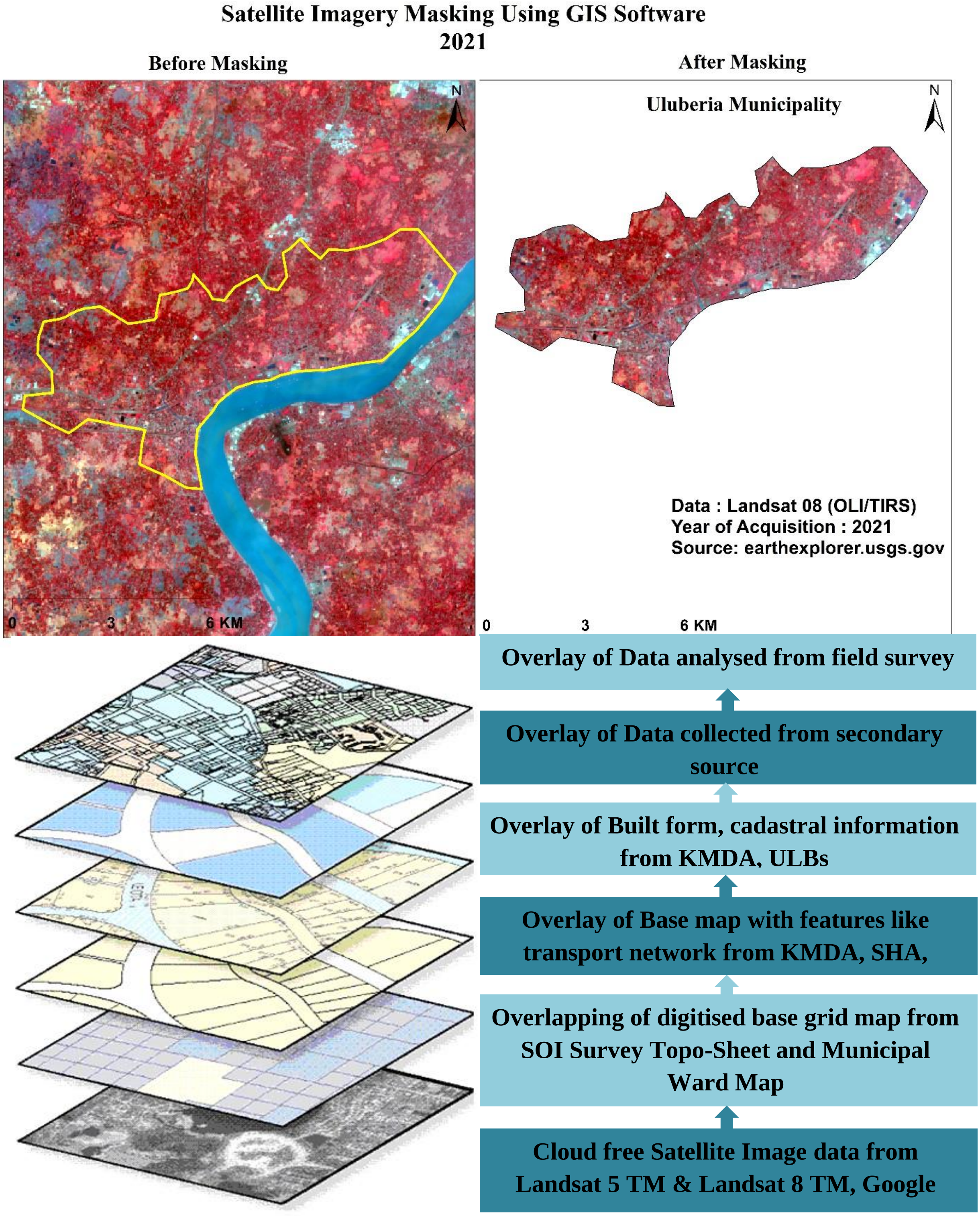


Figure 5. 2 : Diagram of Base map preparation process.
Source: Author

5.2.1.4 Preparation of attribute database

Attribute database generated from District handbook of census corresponding to the years 1991, 2001, 2011. Where attributes used as follows:

- Population
- Growth Rate
- Density
- Land Price (Secondary Data source: "*An assessment of housing affordability inclusive of variations in infrastructure development within a metropolis: case of Kolkata*" - PhD thesis report by Ankhi Banerjee, IIT, Kharagpur)
- Work participation rate
- Transportation
- Built-Area (Residential, Commercial, Public -Semi Public sub categories)
- Agricultural Land
- Vacant Space

Detailed Map of the Study area has been created relating with the Decadal Census year for ease of analysis. The maps of urban area have been derived from the Comprehensive development plan prepared by KMDA. The administrative boundaries of municipal corporation and panchayat areas are followed for stream line the process of delineation. It helped to correlate the secondary data source with the map.

The existing road network, water body, wetlands are drawn from TOPO sheets map of survey of India and KMDA master plan. The future proposals like upcoming roads/ highways, sub urban metro, flyover etc have been collected from Concern govt. Dept./ agencies.

The parameters identified as the driving forces (+ve & -ve) towards urban growth are superimposed as attributes. The main attribute data base is prepared from District census handbook 1991,2001,2011.

Finally, GIS is used to analyse all data spatially to project a future land use scenario (Fig.5.5, 5.6,5.7,5.8).

KMA is one of the country's oldest and largest agglomerations. The Calcutta Metropolitan Planning Organization (CMPO) used and developed the Land Control Act of 1965 to introduce the concept of Kolkata Metropolitan Area (formerly CMD i.e., Calcutta Metropolitan District). According to this Schedule Act, the area of the then Calcutta Metropolitan District was 1380 sq.km., which has now expanded to 1831.58 sq.km. in the deltas of the Hooghly River, covering the entire Kolkata district as well as parts of five other districts, namely 24Parganas (South), 24-Parganas (North), Howrah, Hooghly, and Nadia. The Kolkata Metropolitan Development Authority (KMDA) established the boundary of this area, and the KMDA is in charge of all planning in this area. It is primarily a development agency tasked with carrying out major infrastructure development within KMA (Kolkata Metropolitan Area). After nearly 51 years, KMDA is still the KMA's authority for urban planning and development. One of the most distinguishing features of this well-known metropolitan area is that it is surrounded by rural areas.

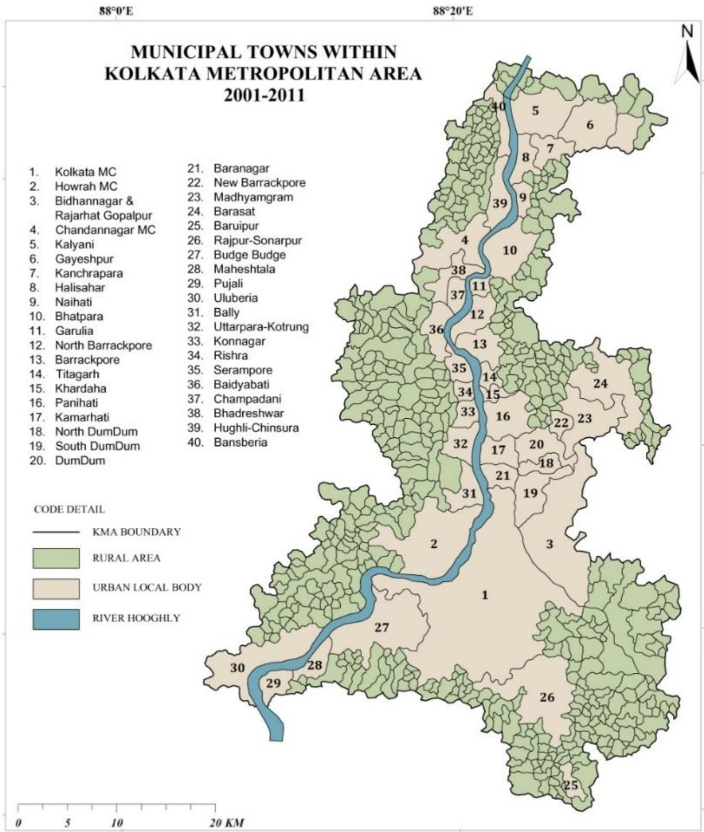


Figure 5. 3 : Kolkata Metropolitan Area showing Municipal Towns/Urban Local Bodies with statutory boundaries. Source: Prepared by author

Table 5. 1 : Composition of KMA: 2011

	Categories of Area	Number in 2011	Area in Sq.Km in 2011.
1	Municipal Corporations	3	271.31
2	Municipalities	39	633.41
3	Census towns	75	193.98
4	Outgrowths	16	18.19
5	Rural Area	446	769.78
			1886,67*

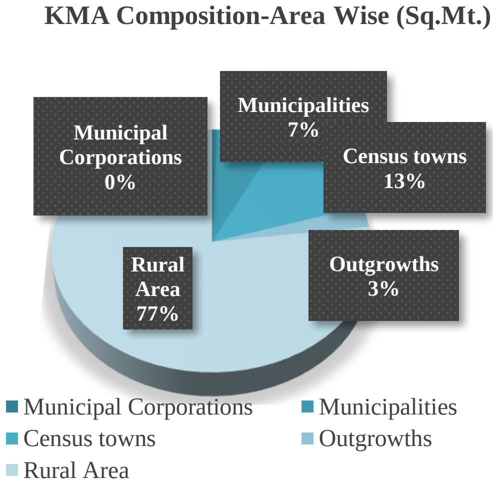


Figure 5. 4: Present Composition of KMA. Computed by author

5.2.2 Land use Feature: Land use change and land availability

The dynamics of land use and land cover in the peri-urban landscape are more complicated and dynamic than everywhere else. As a result of the spill over effects of urbanisation, all of India's major cities are undergoing a change from rural to urban economies. Satellite photos from two different time periods (2001 and 2011) were used to better understand the changes through time.

Built-up areas dominate the urban centre, as shown in Figs. 5.3 and 5.4, and have done so for a long period of time. An extensive land use change has taken place in peri-urban areas over the previous ten years. It has been observed that the built-up area in these regions is fast expanding. In 2001, the built-up area was 37.5 square kilometres, accounting for 9.6 percent of total area;

however, this increased to a high of 110.5 square kilometres, accounting for 28.5 percent of total area, with a phenomenal growth of 195% in 2011. The expansion of PUI's built-up area comes at the expense of vegetation and agricultural land. Conversion of agricultural land to non-agricultural uses is a continuing phenomenon in transitional interfaces as a result of emerging residential, commercial, and other non-agricultural activities. Furthermore, the constant population pressure accelerates the conversion rate. This is most common along transportation corridors, and lands adjacent to cities are more prone to conversion.

Data post processing:

The Landsat images utilized in this research were L1T (Level 1Terrain-corrected data), inferring they were already geometrically corrected (Zhu & Woodcock, 2014.). To procure the FCC (False colour Composite), layer staking of Landsat spectral bands (optical wavelength) was carried out. Thereafter, the images were atmospherically corrected Top of Atmosphere (TOA) and the visualization was improved performing the majority filtering approach to eliminate atmospheric influence that would hinder image analysis. The images were recorded for WGS 84/UTM zone 45 N, RGB colour composition was applied, the mosaic was created, and the area of interest was clipped.

LULC classification:

LULC Classification Methods and Classifier Techniques are extremely flexible when it comes to collecting precise Land Use Land Cover data from remote sensing imageries (Eman, Alshari, Bharti, & Gawali, 2021,). To detect urban expansion and land resource management, precise information on land-use changes from satellite imagery is crucial (J R Jensen, 2007). In addition, procurement of each class according to the colour, tone, and texture is also a vital aspect (Radhakrishnan et al., 2014). The heterogeneous land uses can cause mixed pixel problems particularly in urban areas. Therefore, obtaining accurate information from satellite images is a difficult and challenging job (Lu & Weng, 2005); (Hassan, 2017). The study considered the pixel classification process and thus the supervised classification techniques were performed. The maximum likelihood classifier (MLC) algorithm for LULC classification was executed to the acquired satellite the images of 1991, 2001, 2011 and 2021. The maximum likelihood algorithm encompasses the training data set and their statistical control and fits it to sample size and pixel counts as closely as possible. The maximum likelihood algorithm is based on probability function and it represents more accurate results especially for the multi-temporal classification (Strahler, Woodcock, Li, & Jupp, 1984). Supervised classification approach was conducted by collecting several training samples with known class types in the ground truth. It was then analogized with the spectral signatures of the pixels in the image (Lillesand, Kiefer, & Chipman, 2004). The maximum likelihood algorithm was applied to this study at a regional scale for better observance of the changes in land-use and quantify the spatial extensions of the built-up (Das & Angadi, 2020). The MLC is manifested in the following equations (1 to 3): (Mondal A. K., 2012.) (Patel, 2019)

$$\emptyset = \frac{P(k)P(\frac{k}{x})}{\sum_{i=1}^{m} P(i)P(\frac{k}{i})} \qquad (1)$$

Where, $\emptyset$ = posteriori probability, m = predefined class, $P(k)$ = pixel belonging in class k by prior probability, $P(\frac{k}{x})$ = probability density function where the conditional probability to observe x in class k.

The probability function of this likelihood is expressed as follows:

$$L_k(x) = \frac{1}{(2\pi)^{n/2}|\sum k|^{1/2}} exp[-1/2(x-\mu_k)^T \textstyle\sum_k^{-1}(x-\mu_k)] \qquad (2)$$

Where, $L_k(x)$ = membership function of the likelihood of x in class k, x = x_1, x_2, x_3, x_4,… … . . x_n^T corresponds to a vector pixel in n number of bands, μ = μ_{k1}, μ_{k2}, μ_{k3},… … . . μ_{k3}^T corresponds as mean of k^{th} class.

The k^{th} class covariance matrix is expressed as follows:

$$\sum k = \begin{pmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} \\ \vdots & \vdots & \vdots \\ \sigma_{n1} & \sigma_{n2} & \sigma_{n3} \end{pmatrix} \qquad (3)$$

The signature training set for each land-use class in the image was delegated based on the ground truth information. The spectral signature of each class was derived using the reflectance of the related pixel value (Strahler 1980). Adopting USGS Level-I the LULC classes were selected (Anderson, 1976). Furthermore, the local knowledge and visual interpretation were found to be very useful to obtain precise supervised classification results. The entire landscape of the study area was classified into six different classes: (i) Agricultural land, (ii) Built-up, (iii) Fallow land, (iv) Hooghly river and (v) Inland water bodies (vi) Vegetation.

Prediction of LULC:

LULC prediction incorporating cellular automata based on artificial neural networks:

Artificial neural networks (ANNs) are a popular form of machine learning algorithm that can capture and describe dynamic interactions among inputs and outputs. An artificial neural network (ANN) is a matrix of nodes patterned by the brain's arrangement of neurons. It comprises of a number of neurons or nodes which work together to convert input data into output classes. In most ANNs, there are three layers: input layer, hidden layers, and output layer. On the other hand, depending on the application, each layer in a network has multiple neurons. Each neuron is connected to other neurons in the subsequent layer through direct connections. The weight of these links represents the outgoing signal frequency (Biragani, Yazdandoost, & Ghalkhani, 2016) . In an ANN application, there are several distinct types of networks that can be employed, and the optimum one relies on the challenge and data provided. In Multi-layer perception, artificial neurons, or processing modules, are placed in a multi-layer perception (MLP). The transitional probability model was forecasted in this study using ANN-MLP, which combined land use change-conditioning parameters. Land use transitional probability-conditioning indicators such as agricultural land, built-up, fallow land, Hooghly River, inland water bodies, and vegetation were derived for the LULCs maps of 1991, 2001, 2011, and 2021. From the feature extracted, the Euclidean distance tool in ArcGIS software 10.3 was used to develop proximity metrics. The CA-ANN is a hybrid model that integrates cellular automata (CA) and artificial neural networks (ANN). The CA is composed of the similar components, such as cells, that are placed in a regular and distinct space. The key concept of CA is that LULC transitions of every cell or pixel may be examined by analysing their current status and changes in their neighbours. This includes the application of a transformation rule that is based on nearby cells. To demonstrate transformation rules, the probability of initial and subsequent environments is employed. The proximity principle, which states that areas closer to present regions of the similar class are more likely to convert to a different LULC type, is used to represent the challenges of transition. It is one of CA's most significant features to predict the complicated dynamics of spatiotemporal patterns through a range of transformation rules. The model addresses LULC problems by applying transition probabilities and employing ANN-based suitability maps for each LULC group to make accurate forecasts for the future.

Random forest, decision tree techniques to perform the sensitivity analysis of the anticipated model:

Random forest–based feature selection technique

One of the most widely used efficient ensemble supervised techniques is Breiman's random forest. This algorithm can address the regression problem, classification problems, and unsupervised learning problems. Natural hazard modelling, hydrology, LULC classification, and financial analysis are just a few of the domains where it's been employed (Chen, Hong, & Li, 2019); (Dou, et al., 2020); (Talukdar & Pal, 2020). The RF is formed by combining RSS and bagging (Chen et al., 2019). The main strengths of the RF are its lower multi-colonial exposure and the capacity to consider asymmetrical and missing data. The RF model works in the following steps: (1) Applying bootstrap re-sampling, it produces sub-phases from the existing data that are equal to zero sizes in the initial dataset. (2) Employing the sub-phases, it produces decision trees. (3) It finally generates the output by combining the predictions of all decision trees (Ntree) in the same way.

In this study, the R Statistical package "Random forest" was utilized to perform RF. Three state-of-the-art models were utilized to estimate the parameters influence for land use potential for development modelling after modifying the parameters of these techniques. Tuning is a term that refers to a variety of variable optimization procedures. A frequent technique for parameter optimization is grid search. In this analysis, we employed the grid search technique to calibrate the models, which is critical for assessing their precision and efficiency.

Decision tree–based sensitivity analysis:

Decision Trees is a form of machine learning technique for classifying and predicting non-parametrically supervised systems (Gokceoglu, Nefeslioglu, & Sezer, 2010). The two types of DT considered in modelling are classification trees and regression trees. Regression trees was performed to predict continuous data, whereas classification trees have been applied to anticipate discrete variables. The main concept is to learn many decision rules from the complete data set to develop a model that estimates the impact of a dependent element (Yeon, Han, & Ryu, 274–283). The entire sample was divided into two or more uniform sets, based on the most critical input splitter factors. This approach was employed in the current study in describing projected land use potential models to measure the weight or control strength of different parameters

LULC comparison analysis result:

The results of the comparison after classification indicate the extent and type of change that every LULC class has experienced. The LULC changes in all images were evident, either as an extension or a decrease between sequential dates. Further investigation of these findings will reveal information on the land use activities, trend, and rate of change in the studied area. This knowledge is crucial for planners and decision-makers in the planning field.

Change matrices and statistics for the periods 1991–2001, 2001–2011, and 2011–2021 were developed by comparing classified maps from 1991, 2001, 2011, and 2021.

Multi-temporal LULC that spans multiple time periods encompassed six important categories: (i) agricultural land, (ii) built-up land, (iii) fallow land, (iv) Hooghly River, and (v) inland water bodies, as well as (vi) vegetation in 1991, 2001, 2011, and 2021 as depicted in figures (fig no. 5.5,5.6, 5.7, 5.8). Table (table no.3.1,3.2,3.3,3.4) demonstrates the spatial distribution pattern of LULC as estimated by supervised classification technique. The built-up area has increased significantly between 1991 and 2021, according to the visual study in figures (fig no 5.5,5.6, 5.7, 5.8). Agricultural land and vegetation, on the other hand, have decreased substantially during the 30 years' time period.

According to classified maps, agricultural land occupied roughly 22.21 percent of the study area in 1991, fallow land accounted for 3.97 percent, built-up area accounted for 7.64 percent, vegetation, inland water bodies and Hooghly River accounted for 7.75 percent. 0.89 percent and 1.28 percent of the Kolkata Metropolitan area, respectively. On the other hand, in 2001 about 10.27% of the area was covered by agricultural land against 22.21% area in 1991 showed a decrease in cultivated land. Fallow land, vegetation area covered 7.05% and 5.78% respectively, while built-up had largest share of 18.09% followed by inland water bodies and Hooghly River as 1.27% and 1.29% respectively. Results from the classified image of 2011 illustrate that around 23.8% of the area was covered by built-up, while agricultural land was found to get increased by 1.15% with respect to the preceding decade. Fallow land, and vegetation decreased by 4.11% and 4.31% respectively whereas, inland water bodies increased its share to 1.26% and 0.03% respectively. Interestingly, in year 2021, a significant decrease of about 4.05% and 2.37% from the previous decade was noticed in the ground coverage of agricultural and fallow land classes. A steady increase in built-up of about 4.81% was observed. In contrast, the total area for the vegetation class increased from 1.47% in year 2011 to 4.36% in 2021 while inland water bodies and area covered by the Hooghly River was found to have a decrease by 0.97% and 0.098% respectively. The details of the land use-land cover comparison analysis are represented in table (table no.3.1,3.2,3.3,3.4.)

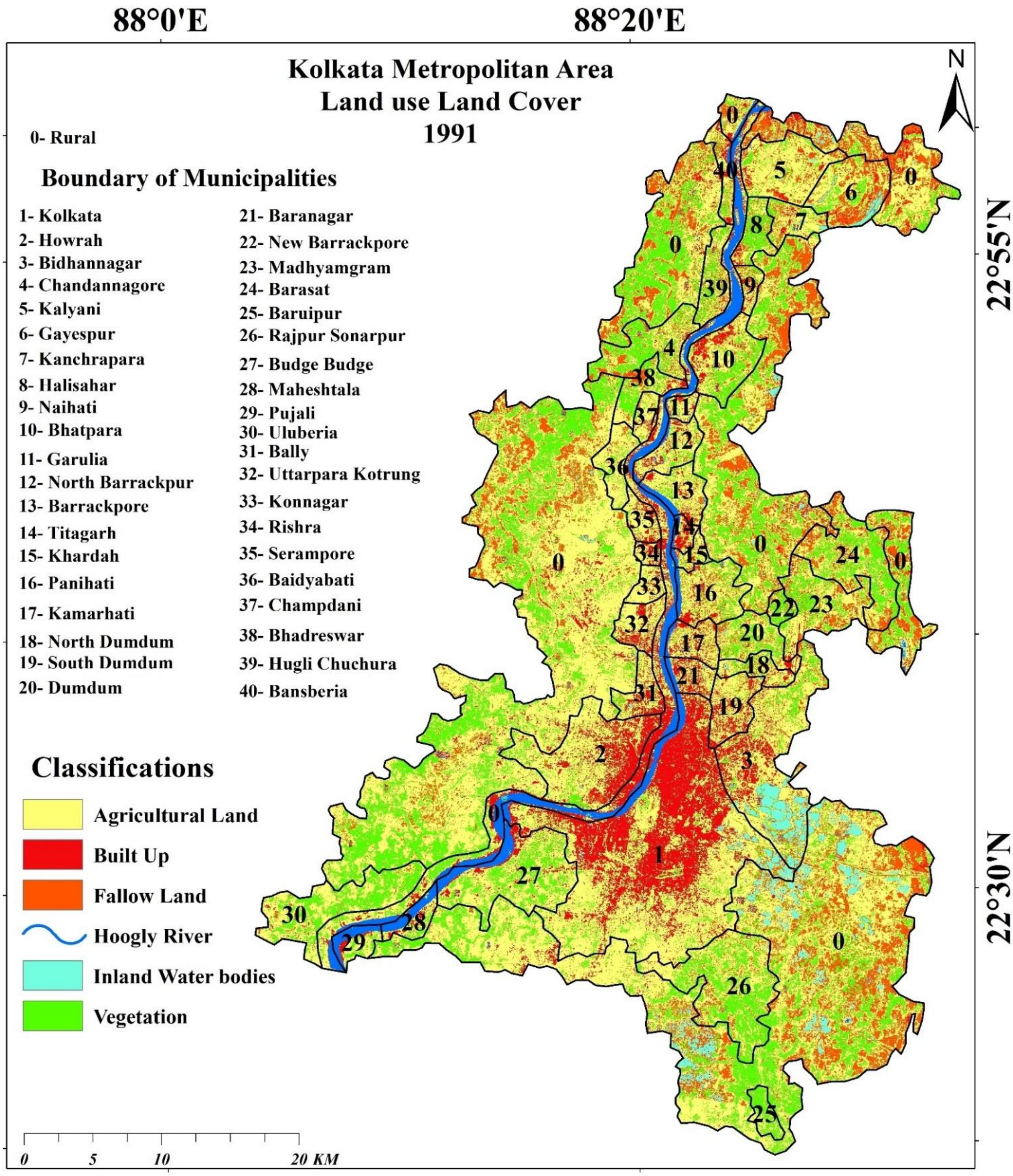


Figure 5. 5 : LULC mapping of Kolkata Metropolitan Area-1991
Source: Composed by the author from database of Landsat data, KMDA, SOI Data

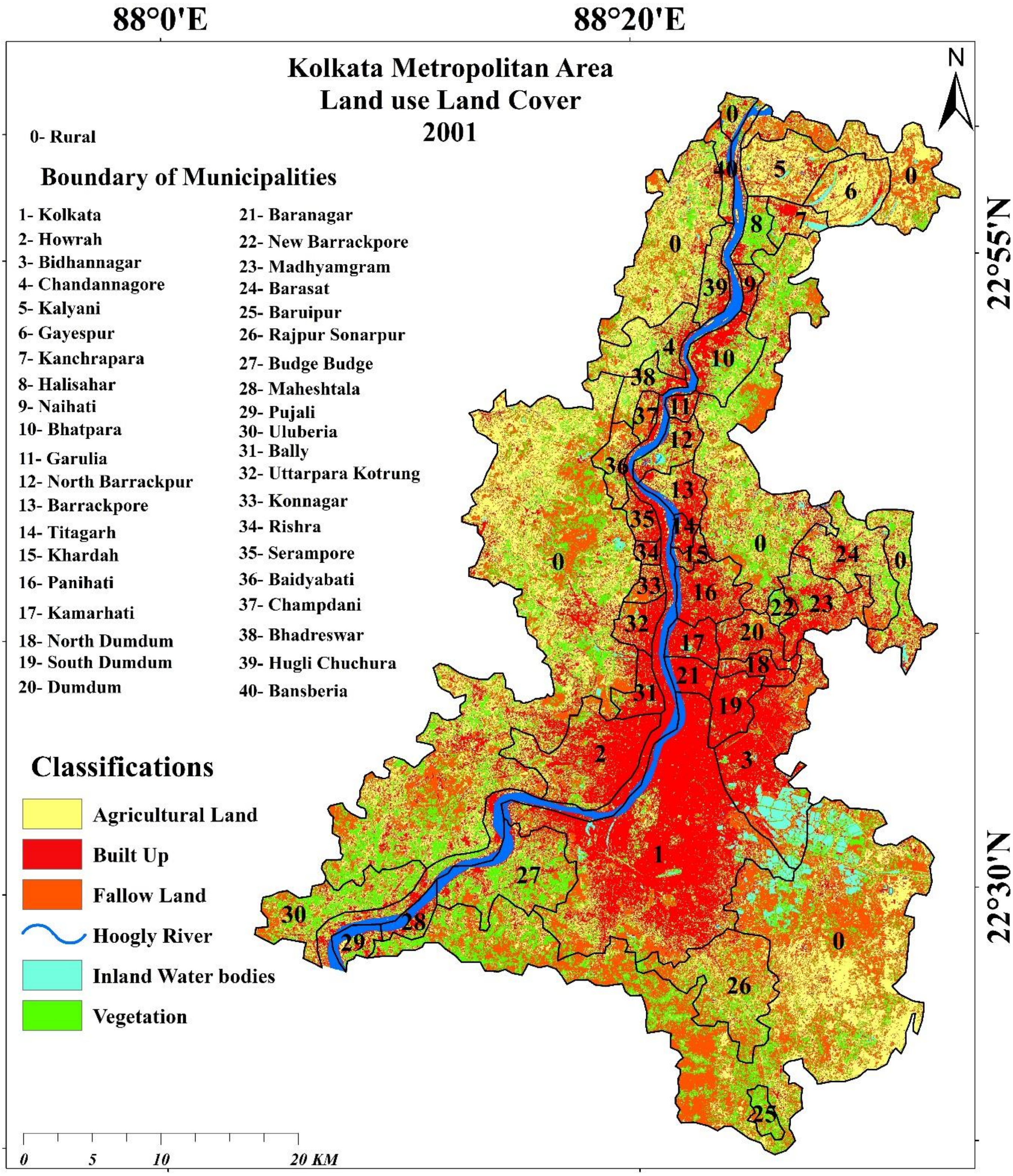


Figure 5. 6 : LULC mapping of Kolkata Metropolitan Area-2001
Source: Composed by the author from database of Landsat data, KMDA, SOI Data

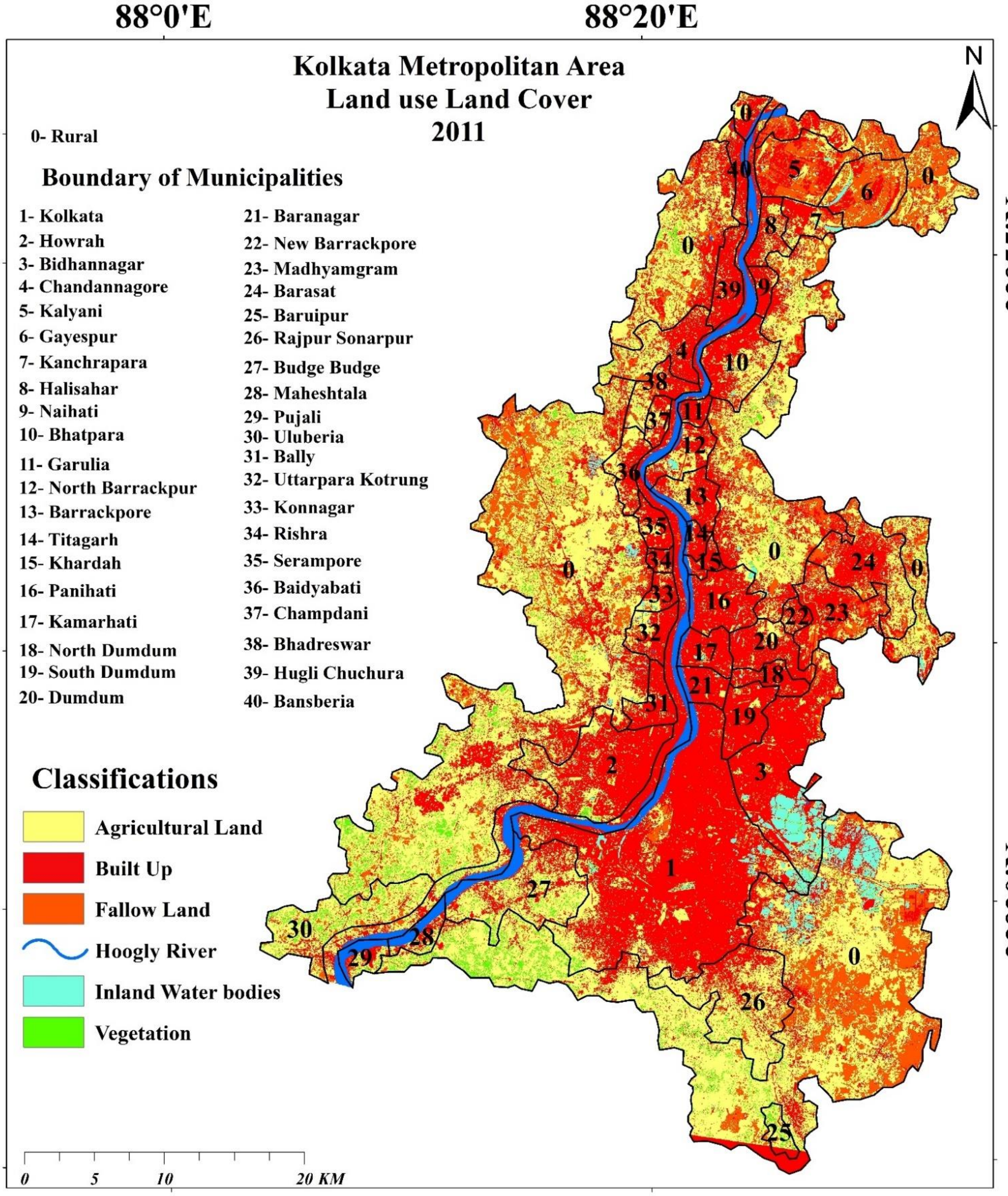


Figure 5. 7 : LULC mapping of Kolkata Metropolitan Area-2011
Source: Composed by the author from database of Landsat data, KMDA, SOI Data

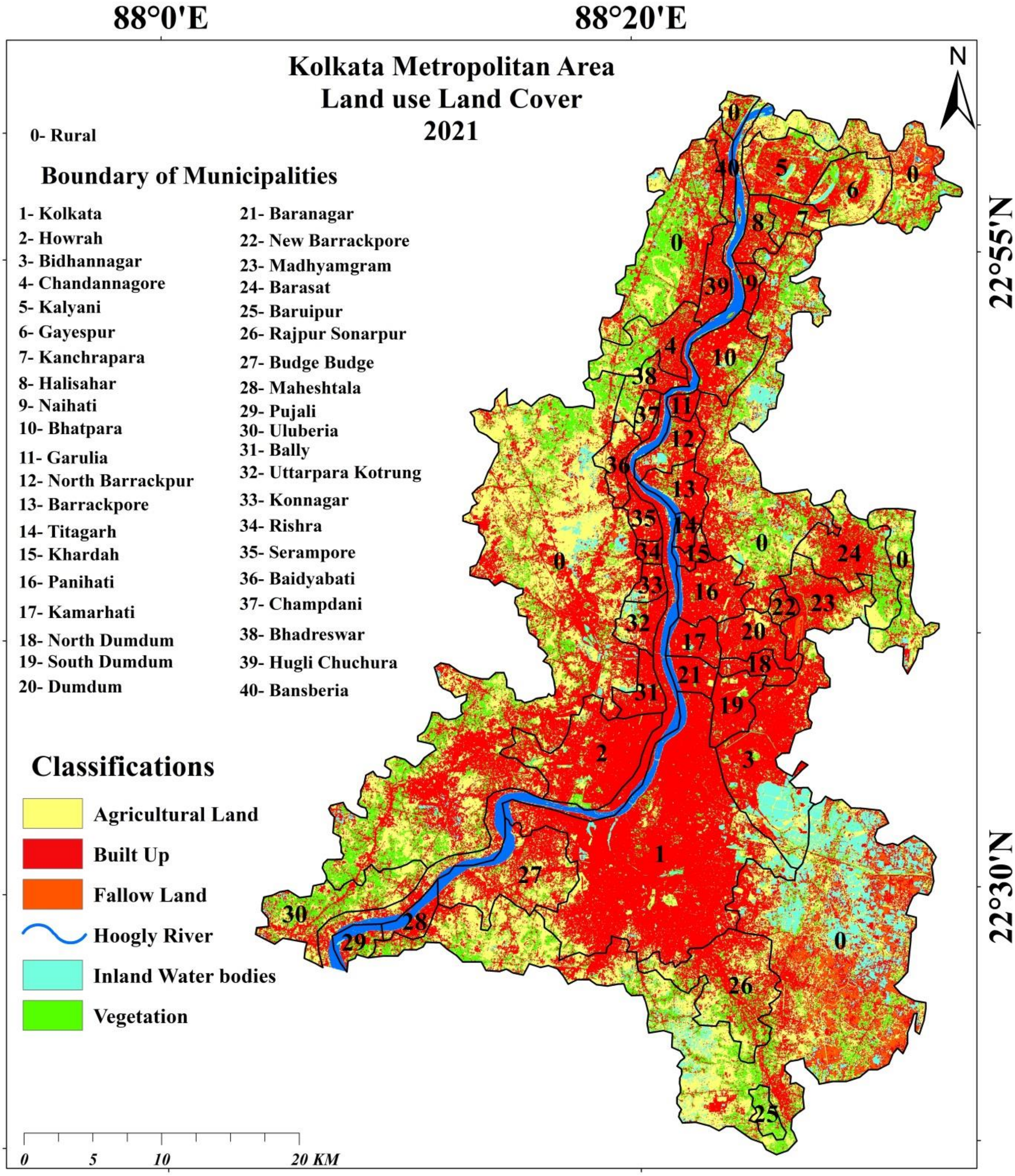
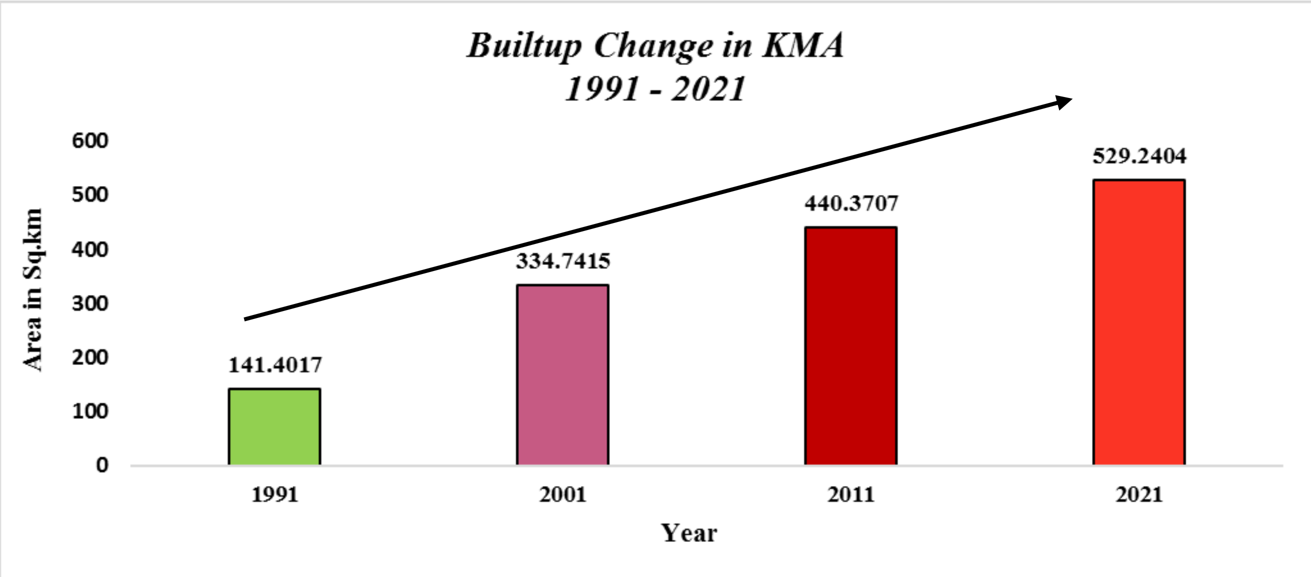


Figure 5. 8 : LULC mapping of Kolkata Metropolitan Area-2021
Source: Composed by the author from database of Landsat data, KMDA, SOI Data

In previous analysis Built up area has been used as synonymous of urban area. While studying Land availability the prominent built-up area has been give 1 score. Available agricultural land is given score 2 as these areas will have tendency to convert in urban area in next decade. But forest land, wet land, and large water bodies are scored 0. These areas need protection from encroachment.

5.2.2.1: Outcome of LULC change over time



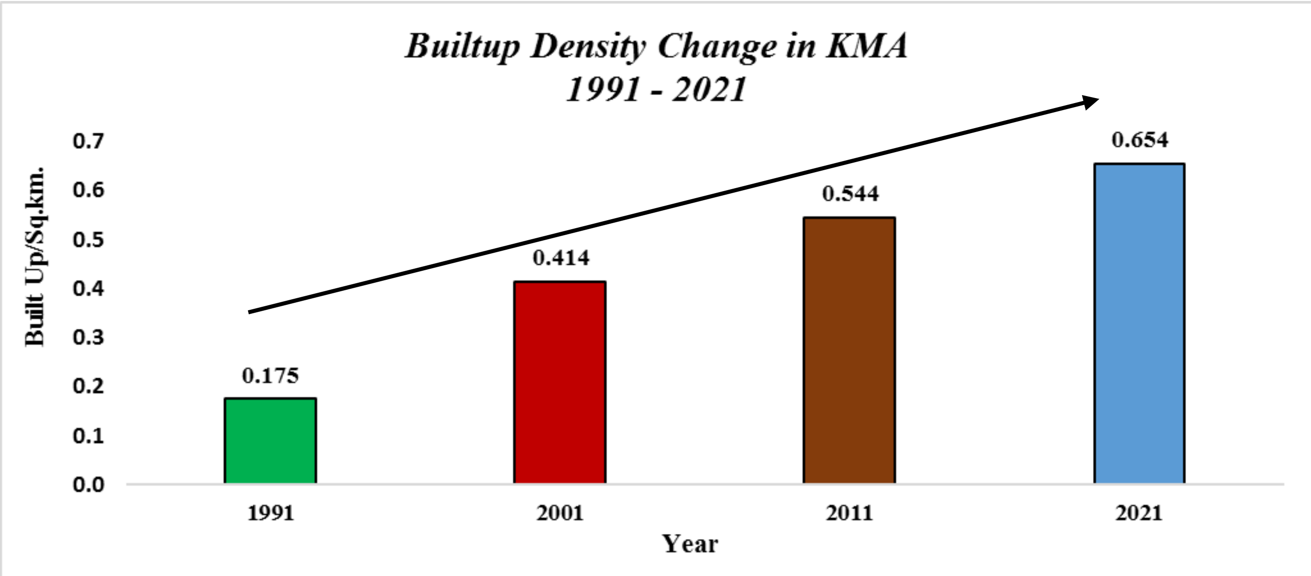


Figure 5. 9 : Graph showing change in built-up area in KMA
Fig 5.9a: Graph showing change in built-up density in KMA
Source: Prepared by author based on LULC mapping

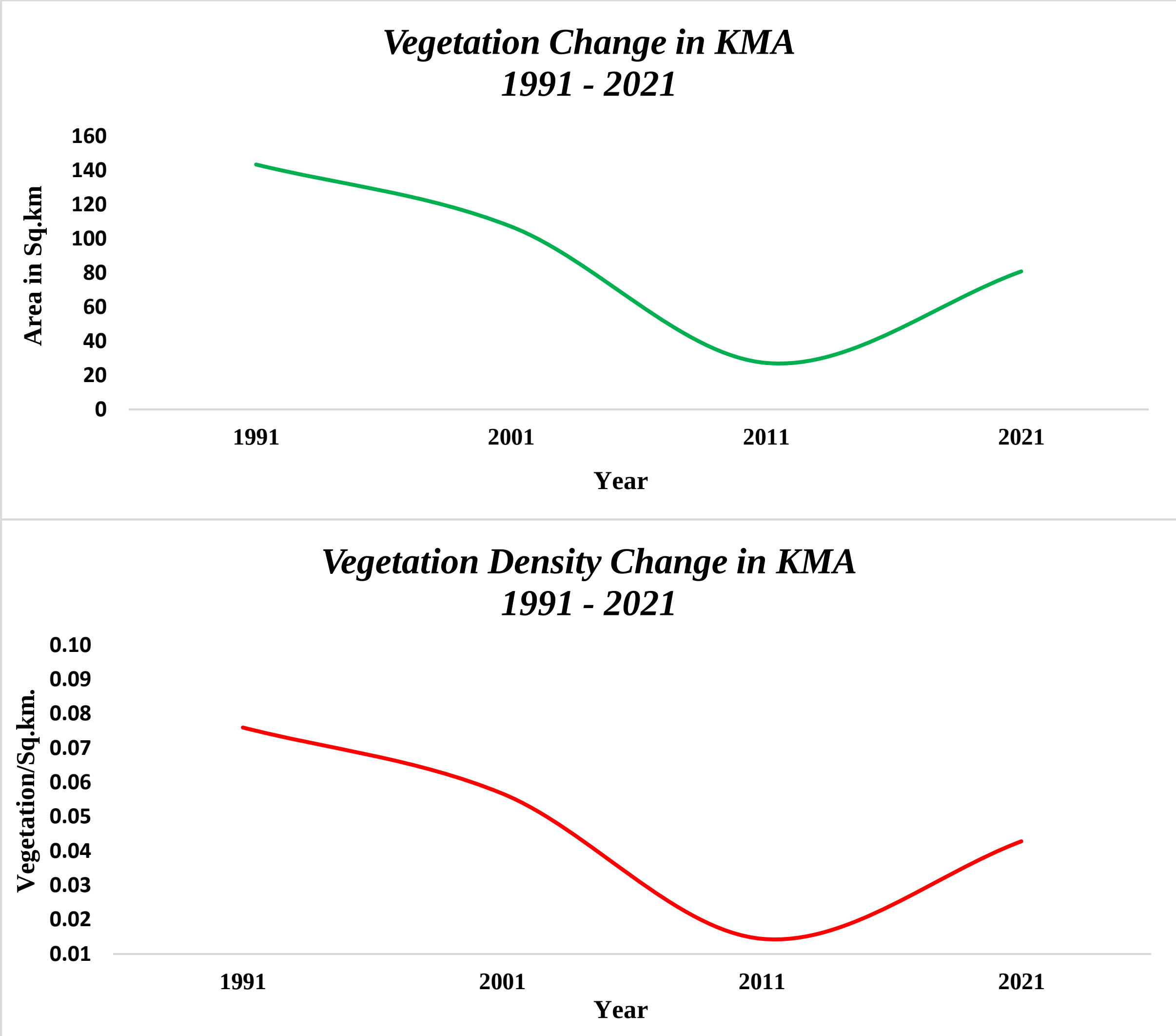
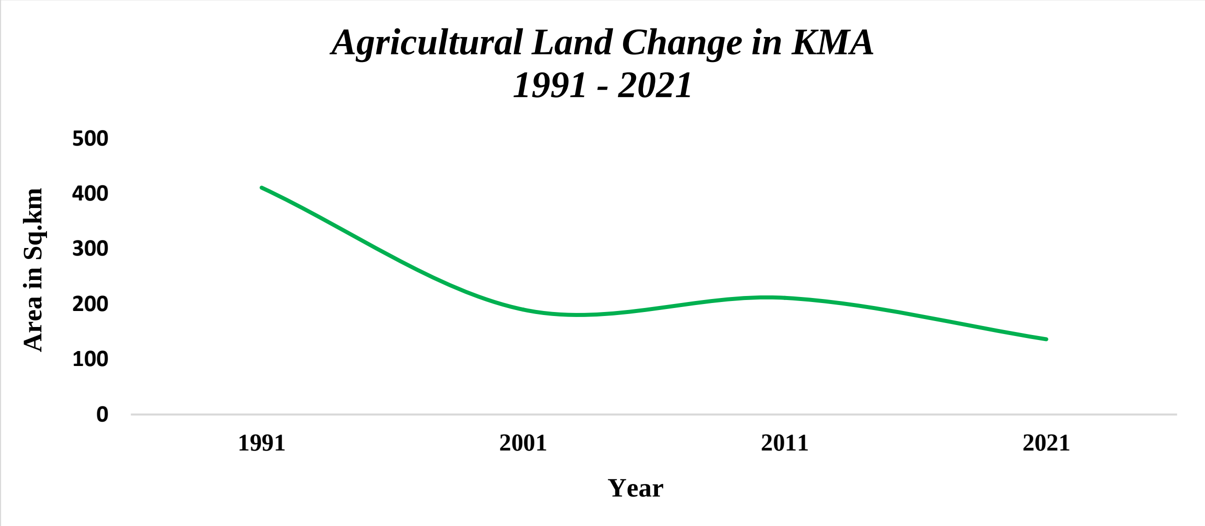


Figure 5. 10 : Graph showing change in vegetation area in KMA
Fig 5.10a: Graph showing change in vegetation density in KMA
Source: Prepared by author based on LULC mapping



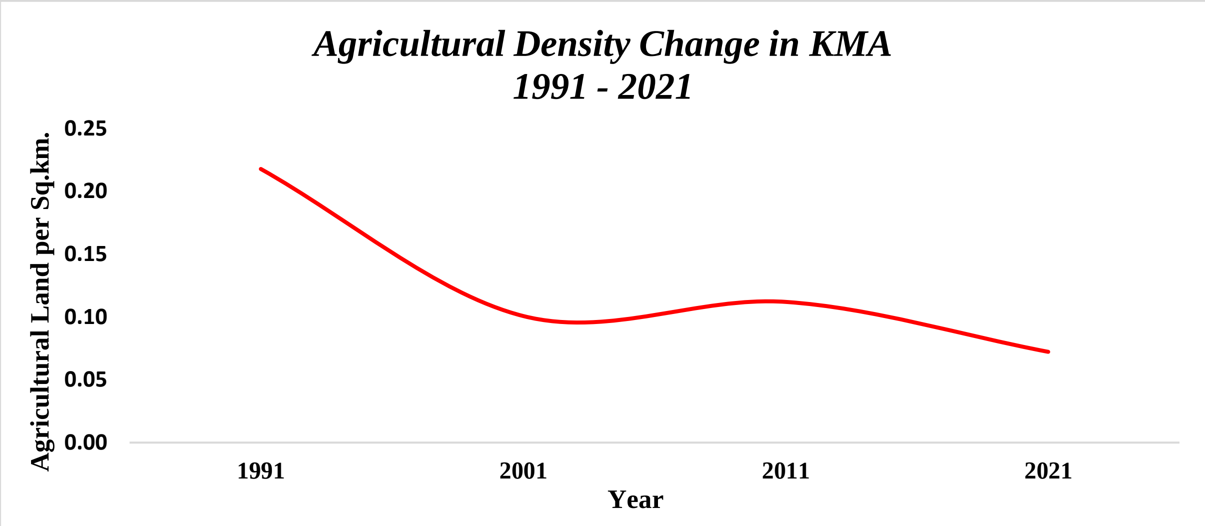


Figure 5. 11 : Graph showing change in agricultural area in KMA
Fig 5.11a: Graph showing change in agricultural density in KMA
Source: Prepared by author based on LULC mapping

- **City form observed:** the city of Kolkata developed linearly following north south direction of rives Hooghly along with its twin city of Howrah. However, being the major financial hub of eastern region the city expanded a little radially during 2001 rapidly from what is was in the year 1991

- **City sprawl pattern observed :** the city sprawl or new additions of peri-urban settlements happened towards north south region following the direction of the river.

- **Built-up area change:** the change in built-up area as shown in the fig 5.9a& b took a sharp accent from 1991 to 2001 and then on increasing steadily till 2021 within KMA. In the period of 1991-2001 the major settlement generation happened (more than 100%)in kma while the percentage of settlement generation inside Kolkata was around 52%. 2001-

2011 31% in KMA and 23% in Kolkata while from 2011-2021 20% in KMA and 8% in Kolkata.

- **Vegetation and Agricultural land change:** As a result decline in vegetation area and loss of Agricultural land jump started during 1991-2001 and then on steadily decreasing as can be seen from LULC mapping and quantification therefore.

5.3 Model 2: Delimiting urban area based on urbanisation indicators

Peri-urban areas are in the process of transforming from rural to urban economies, with attributes of both rural (i.e. mostly agricultural) as well as urban (i.e. mostly non-agricultural) land use type (Adell, 1999). Such transitional spaces, that also exist beyond the municipal boundaries, cultivate difficulties, challenges and dynamism over time. Nevertheless, there really is no standard methodology for demarcating such areas due to its complicated characteristics of high population growth and geographic growth, as well as their irregular and continually evolving morphological characteristics (Pryor, 1969); (Mondal & Sen, 2020). As a result of data constraints, some scholars use the phrase "districts around metropolises" (Sen S. , 2016)or arbitrary "buffer zones" to describe peri-urban areas (Shaw A. , 2005); (Gowda, et al., 2012), while others use "buffer zones" (Sen S. , 2016) to describe peri-urban area (Banu & Fazal, 2013). When it comes to the peri-urban interface, Brook and Purushothaman contend that there is no single adequate description that applies in all contexts. It's possible that they'll change in the same place throughout time.

It is a process of urban expansion that originates from the city centre. As a result, this process tends to have a greater impact on the areas that are closest to the metropolis. These Community Development Blocks (also known as CD Blocks) were selected for this study because they are next to one another and have been identified at the village level. Unified Local Bodies (ULBs) manage the urban areas and Gram Panchayats govern the rural parts in India, respectively (e.g. village council). Peri-urban spaces, despite their appearance, are governed by the Gram Panchayat because the Nagar Panchayat, which the 74th Constitutional Amendment (1992) specifically mandated as a separate governing body for the areas under transition, has not been implemented in most states of India in general and West Bengal in particular (Shaw, 2005).

5.3.1 Zone of Impact:

In contrast to urban areas, peri-urban areas in India do not have a uniform definition. There are three normative parameters used to determine peri-urban areas, based on their features and the availability of data. These are: **1) minimum population of 4000; 2) at least 50% of principal working individuals are men; and 3) population density of 300 persons per square km.**

These standards are somewhat lower compared to the criteria of Census definition for urban areas *(Census of India defines urban area as "all places with a municipality, corporation, cantonment board or notified town area committee, etc." or "all other places which satisfied the following criteria: i) A minimum population of 5000; ii) At least 75 per cent of the male main working population engaged in non-agricultural pursuits, and iii) A density of population of at least 400 persons per sq. km").* It's important to note, however, that while these cut-offs are ad-hoc in nature, they help identify potential transitory zones between rural and urban areas. These criteria are based on demographic and socioeconomic factors, which makes them unique. Peri-urbanisation also includes the coexistence of urban and rural land uses, as well as a growing built-up region that reflects a growing urban footprint. Considering that built-up area is typically used as a synonym for urban land use, it has also been utilised to identify transitional spaces. However, there is no pre-existing acceptable standard norm for the built-up area coverage, unlike the Census criterion for urban areas. A survey of built-up areas in and around Kolkata's metropolitan region revealed that 10 percent coverage was regarded the normative benchmark for this study in order to address the issue at hand. Due to it, the city-specific norm utilised in this study could have a wildly varying average value depending on the city. Peri-urban areas are defined as settlements (villages and settlements meeting Census criteria, i.e. census towns) that meet the above criteria and also have more than 10% built-up area coverage, implying mixed land use characteristics. The inclusion of census towns in this demarcation process is due to the fact that, while they are recognised as urban by the Census of India, (Gowda, et al., 2012) they are actually administered by the Gram Panchayat, just like other rural areas (Shaw A. , 2005).Type of governing institutions, whether rural or urban bodies, is an important underlying characteristics for the development of any area as the rules and regulations, provision of services, planning process etc vary among these institutions.

These areas are reliant on Central Business District for commercial and occupational activity. This research finds out that an average 60-75 % of work trip is generated daily destined to CBDs (which has been elaborated in the later part of this chapter) from the sub-urban areas also due to globalization range of market and occupational opportunities are increasing day by day in the CBDs.

Studies have indicated that urban expansion and three primary reagents of growth, governance, and globalisation have had a significant impact on the economic status of peri-urban communities. Due to their locational advantages, enhanced transportation networks, and cheaper land, these transitional zones around cities emerge as new economic spaces that attract various companies and development activities (Shaw A. , 2005). It has been noted that many industries are also transferred to these areas, especially polluting sectors from the urban centre, as Dupont (2005) found in Delhi. The Rajiv Gandhi Technology Park in Chandigarh and HITEC City in Hyderabad are two instances of SEZs and IT parks that have sprung up in such peri-urban areas (Kennedy, Cuddihy, & Engel-Yan, 2008). Kolkata's tanneries have also met with such dislocation. Thus, India's major cities are all affected by this problem. There are therefore more prospects for employment in expanding non-agricultural sectors, easier access to markets, more services and commerce, and many other benefits that come with being close to important market centres (Lanjouwa, JaimeQuizon, & Sparrow, 2001); (Mandere, Ness, & Anderberg, 2010); (Tuyen, Lim, & Cameron, 2014). Consequently, peri-urban zones around cities have attracted both the destitute and the wealthy (Sridharan, 2011). However, the main motive for impoverished people to migrate is the availability of economic opportunities, whereas for the affluent sectors, it is the lack of congestion and the availability of inexpensive land for investment. Peripheral cities, they say, "provide both urban and rural benefits" (Mahavir, 2011). They can make use of some metropolitan amenities, as well as a rural lifestyle and inexpensive land. The result is that these transitional areas beyond the city limits undergo tremendous population increase due to their dynamic nature, whereas the city core is more or less stagnant (Shaw A. , 2005). When it comes to peri-urbanization processes, the question arises as to how they affect the economic conditions of peri-urban dwellers. These challenges of peri-urbanization in India are explored in this research using Kolkata as a case study. Study examines dynamic changes in peri-urban areas connected to demographic and land use features, as well as the effects on employment structure that resulted from the 3Gs. Located in eastern India, on the banks of the Hugli River, Kolkata is India's third-largest urban agglomeration after Mumbai and Delhi. It is one of India's oldest and largest cities with a population of 14,2 million, according to the 2011 Census of India. Due to expanding transportation networks, highways, and trains, the metropolitan city has seen dynamic exchanges within its vast hinterland that extends over adjacent districts. Residents of peri-urban areas travel to the city for employment through suburban railways, and both commuter numbers as well as commuting distances in Kolkata have increased dramatically over time (Basu & Dhar, 2012). As reported, Kolkata's core region (KMC) has had a negative growth rate of 1.83 percent during the last decade (2001-2011), whereas the peri-urban areas have continued to expand faster. In light of this, we can say that the present research is justified. A decadal census is the sole source in India that offers detailed village-level data. Primary Census Abstracts (PCA) of Census of India, 2001 and 2011, at the village level, were used to collect data on population and workforce composition for this study. USGS-Earth Explorer (USGS-EE) satellite imagery of Landsat 2017 and Landsat 2000 has also been classified using the Supervised Maximum Likelihood Method (SMLM). For the purpose of extracting coverage of village built-up areas, ARC GIS-10.2.2 software was used to superimpose this on the village boundaries.

5.3.2 Tracing out the Peri-urban areas of KMA:

It is observed that although a huge area surrounds the Kolkata Metropolis, only 196 settlements are considered as peri-urban spaces. From this analysis, the transitional spaces have been categorised into two groups: peri-urban category-1 (PU:C1), i.e. settlements fulfilling the Census criteria of urban and cover more than 10 per cent built-up area and peri-urban category-2 (PU:C2) including the villages fulfilling **all three criteria {1) minimum population of 4000; 2) at least 50% of principal working individuals are men; and 3) population density of 300 persons per square km.}** and also with more than 10 per cent built-up area.

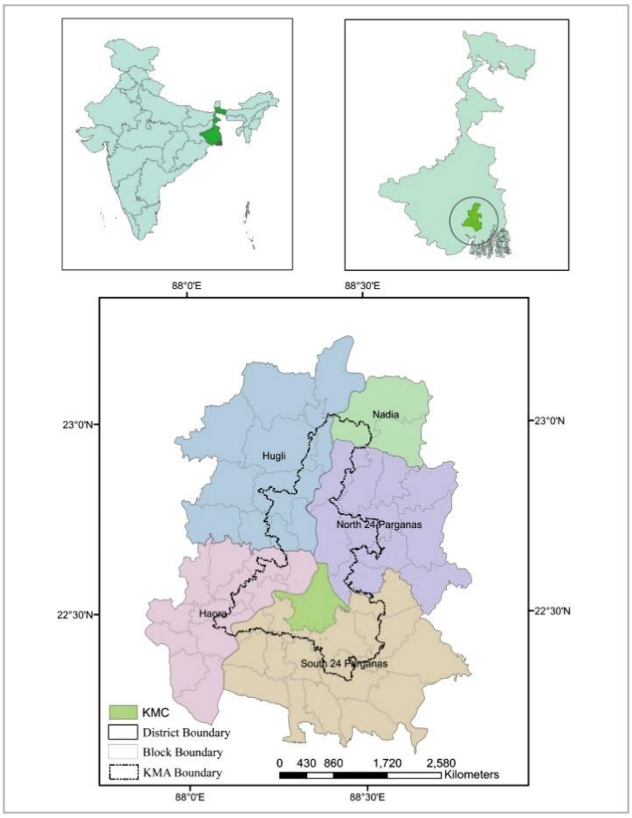


Figure 5. 12 : Kolkata metropolitan area cover superimposed on KMC and surrounding Districts. Source: Prepared by the author.

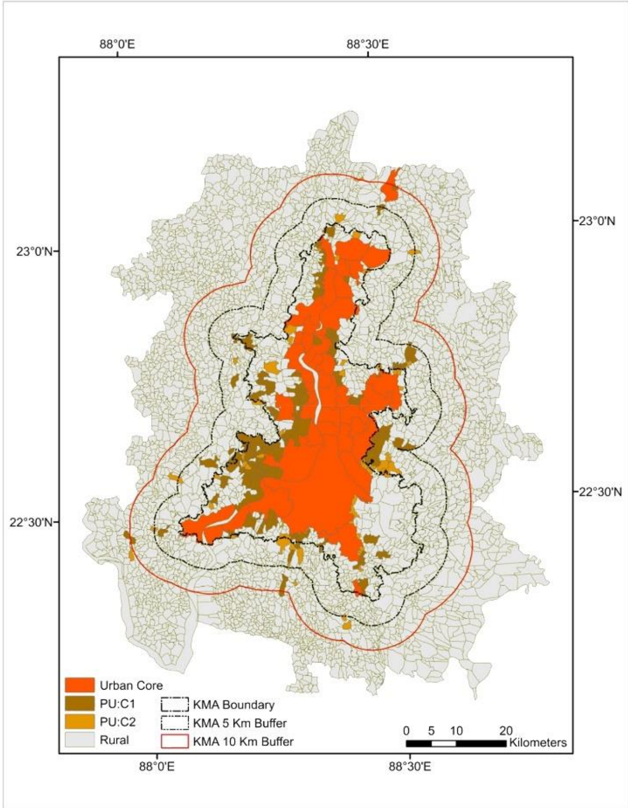


Figure 5. 13: Kolkata Metropolis and its peri-urban areas. Source: Prepared by the author.

Fig. 5.12 shows the location of Kolkata Metropolitan Area in the surrounding district of Kolkata whereas Fig. 5.13 marks the 5 km rings around the Kolkata Metropolitan Area to locate the PU-C1 and PU-C2 categories for further study area demarcation.

5.3.3 Population growth in and around KMA:

In the first half of the 20th century, India's urban population grew primarily within the city limits. However, "much of India's population growth and migration to cities has been accommodated by squeezing more people into existing urban areas rather than expanding cities into suburbs and periphery areas" in complete opposition to the western scenario (Brush, 1977). But in recent decades, this pattern of population absorption in cities has shifted, particularly in large metropolitan areas (Shaw, 2005). While the population of large cities is growing, their spatial coverage, i.e. lateral expansion is also growing at the same time.

Table 5. 2 : Quantifying different categories of Peri-urban areas around the city of Kolkata

Area		Buffer Zone	Total Number	Peri-urban (PU)	PU to Total (%)	Zone to Total (%)
Peri-Urban Area	PU:C1	Inner Zone	196	119	60.71	54.14
		Intermediate Zone	62	16	25.81	17.13
		Outer Zone	104	5	4.81	28.73
		Total	362	140	38.67	100
	PU:C2	Inner Zone	87	41	47.13	25.22
		Intermediate Zone	84	11	13.1	24.35
		Outer Zone	174	4	2.3	50.43
		Total	345	56	16.23	100
Rural Area		Inner Zone	442			11.67
		Intermediate Zone	782			20.65
		Outer Zone	2414			63.74
		Total	3638			100

Source: Computed by author.

The phenomenal population growth in Kolkata's peri-urban districts has been a strong indicator of the city's spatial expansion throughout time. Kolkata Metropolitan Area (KMA urban)'s core, which contains 47 Urban Local Bodies (ULB), displays a decadal population growth of barely 4.39 percent (Table 5.2). Even though Kolkata (KMC) has seen a negative population growth rate (–1.83%) over the last 10 years, this is in stark contrast to its decadal growth rate of 3.93 percent over the period 1991 to 2001. "City of palace's" population decline began in the 1980s in some Kolkata Municipal Corporation's wards, and has since expanded to other places in the following decades (Shaw, 2015).

India's big cities are stagnant or losing population, but the peri-urban areas continue to develop at an incredible rate (Shaw, 2015). With an average decadal growth rate of 24.43 per cent, the peri-urban areas around Kolkata are experiencing substantial population increase. When compared in terms of its growth in transitional areas, it's the peri-urban category-2 PU:C2 (village) with 34.78 percent followed by PU:C1 (e.g., settlements that satisfy census requirements) with 22.74%. Even in rural areas, the population growth rate is higher (15.74%) than in the central core city. According to Sita and Bhagat's 2007 research, the population increase of urban agglomeration, defined as "a continuous urban spread containing a town/city and its bordering outgrowths," is far quicker than that of the city proper, demonstrating peri-urbanisation in India's main cities.

Urban core populations have risen from 12.81 million to 13.37 millions in the last decade, while their share of the total population has declined by 3 percentage points. These people are being subsumed by the suburbs, as the percentage of people living in PUIs has risen from 7.05 percent to 7,98 percent.

5.3.4 Population density:

There are many reasons why people choose to move from the countryside to the city in India, but cities, especially the larger ones have always been attractive because of their better opportunities – employment facilities, education and health services, administrative service and overall a higher quality of life (Bhagat, 2010; Sridhar, Reddy, & Srinath, 2010). This is accurate not only about Kolkata, but also of other major Indian metropolitan cities, Delhi, Chennai, Bangalore, and Hyderabad (Shaw, 2015).

Table 5. 3 : Population dynamics in peri-urban Kolkata, 2001-2011

Area	Population	Population (%)	Population Growth	Population Density	Area	Population	Population (%)	Population Growth
		2011	2001	2011	2001	2001-11 (%)	2011	2001
Urban Core		13379546	12817290	52.69	55.51	4.39	13884	13386
Peri-urban	PU:C1	1718838	1400387	6.77	6.06	22.74	5620	4581
	PU:C2	307956	228489	1.21	0.99	34.78	2898	2150
Rural		9987480	8644513	39.33	37.44	15.54	1670	1446
Total		25393820	23090679	100	100	-	-	-

Source: Computed by author.

People are moving into urban areas as a result of this. While Kolkata's metropolitan core has a population density of 13,884 persons per square kilometre in this example, it's important to note that just 498 inhabitants have been added to the total strength in the recent decade (Table 5.3). Population density in peri-urban districts of Kolkata has been expanding significantly over the previous decade, which is surprising. 5620 and 2898 residents per square kilometre in PU:C1 and PU:C2, respectively and with an increase of 1039 and 748 people over the decade, indicate that peri-urban areas are growing at a quicker rate than the metropolitan city centre.

On account of urban core saturation and overpopulation, peri-urban areas closer to the city are emerging as alternative spaces with improved transit systems, allowing peri-urban residents to live in an environmentally friendly environment with cheaper housing and lower income tax systems, while also being conveniently commutable to the city for work in the downtown core. Kolkata and other large Indian cities have seen a significant increase in the number of daily commuters and commuting lengths as a result of the city's continuing growth.

5.3.5 Occupational structure

Peri-urbanisation and city spatial expansion cause changes in the peri-urban livelihood scenario (Narain, Anand, & Banerjee, 2013).Decentralization of the production system from the urban core to the periphery, facilitated by low-cost land and labour, improved infrastructure, and improved transportation networks, creates job opportunities in emerging non-agricultural sectors (Tacoli, 2012). It has been discovered that the regional work participation rate (WPR) has been increasing over the last decade, albeit at a marginal rate (Table 5.4). However, due to industrial expansion in these interfaces, this increase in WPR has been much faster in peri-urban interfaces than in urban and rural areas over the decade.

Work Participation Rate (WPR) considers the number of people who work without taking into account the differences between different types of workers, such as main and marginal workers. The majority of workers in all areas – urban, peri-urban, and rural – are main workers, with the share in the urban core being slightly higher than in other areas. Another important aspect of occupational structure is the decade-long trend of work marginalisation in all areas. In 2011, the rural area had the highest percentage of people involved in marginal employment (23.5%), followed by peri-urban (13.9%) and urban core (13.9%). However, the amplitude of marginalisation (i.e. increase in marginal workers) varies from 2001 to 2011, with the urban core having experienced the greatest increase with a 3.96% increase in marginal workers over the last decade, while rural areas encountered a 3.02% increase and peri-urban interfaces witnessed a 1.555% increase.

In terms of WPR, share of main workers, and share of marginal workers, thus it is comprehended that peri-urban areas represent an economic continuum in the spatial context between the urban core and rural areas (Table 5.5). In general, the peri-urban areas benefit from urban effects in terms of economic benefits as a result of peri-urbanisation around cities. Sen (2016) uncovers such a spatial continuum in a study of six large metro cities in India, after going into detail the economic conditions of peri-urban regions using various indicators such as average per capita operating costs, people employed in the organised sector, and wages. Surprisingly, in light of the growing trend of work marginalisation, the spatial continuum breaks and peri-urban areas resist this marginalisation process. The emergence of diverse economic activities in these interfaces could be one of the reasons, as peri-urbanisation opens up a wide range of economic activities ranging from farming, animal husbandry, and small industries to large-scale industries and IT sectors. (Tacoli, 2012); (Narain, Khan, Sada, & Singh, 2013).

Table 5. 4 : Population dynamics by distance zone in Kolkata Metropolitan Area and surrounding, 2001-2011

Area	Buffer Zone	Population		Population %		Population Growth	Population Density	
		2011	2001	2011	2001	2001-11 (%)	2011	2001
Peri-urban	Inner Zone	1745823	1397906	86.14	85.82	24.89	5176	4147
	Intermediate Zone	209738	170893	10.35	10.49	22.73	3683	3001
	Outer Zone	71233	60077	3.51	3.69	18.57	3986	3362
	Total	2026794	1628876	100	100	24.43	4918	3954
Rural	Inner Zone	1902935	1625023	19.05	18.8	17.1	1975	1686
	Intermediate Zone	2276811	1976486	22.8	22.86	15.19	1719	1492
	Outer Zone	5807734	5043004	58.15	58.34	15.16	1573	1367
	Total	9987480	8644513	100	100	15.54	1670	1446

Source: Computed by the author.

Table 5. 5 : Occupational structure in peri-urban zones of Kolkata, 2001-2011

Area		WPR%		Main Worker%		Marginal Worker%	
		2011	2001	2011	2001	2011	2001
Urban Core		37.14	34.79	88.9	92.83	11.1	7.17
Peri-Urban	PU:C1	37.48	33.31	86.58	87.92	13.42	12.08
	PU:C2	36.26	32.39	83.08	85.71	16.92	14.29
Rural Area		37.02	33.84	76.55	79.57	23.45	20.43

Source: Computed by the author.

Previously, the Census of India provided a detailed nine-fold industrial classification of employment pattern for each settlement (i.e. village and town), but beginning in 2001, it only provides data on four-fold classification-cultivator, agricultural labourer, household industry worker, and other worker under two broad headings of main and marginal workers. The employment patterns in urban and rural areas differ depending on the available resources and opportunities. According to Fig. 5.14, the majority of the main workers (more than 95%) in the urban core of Kolkata metropolis are engaged in other work, such as public servants, private jobs, and so on, whereas rural areas are directly or indirectly dependent on agriculture, and peri-urban areas show a pattern in between the two. Because of the transitional nature of the rural to urban economy, some people continue to work in agriculture at these interfaces, but a significant proportion of the labour force is now shifting to non-agricultural activities.

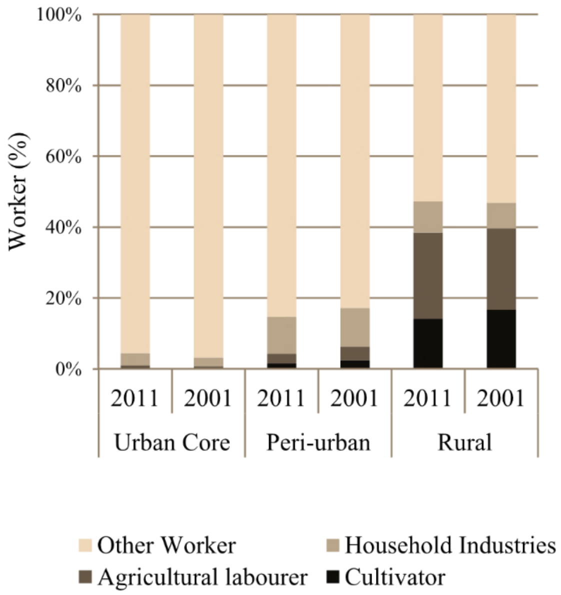


Figure 5. 14 : Workforce composition of main worker, 2001 - 11. Source: Prepared by the author

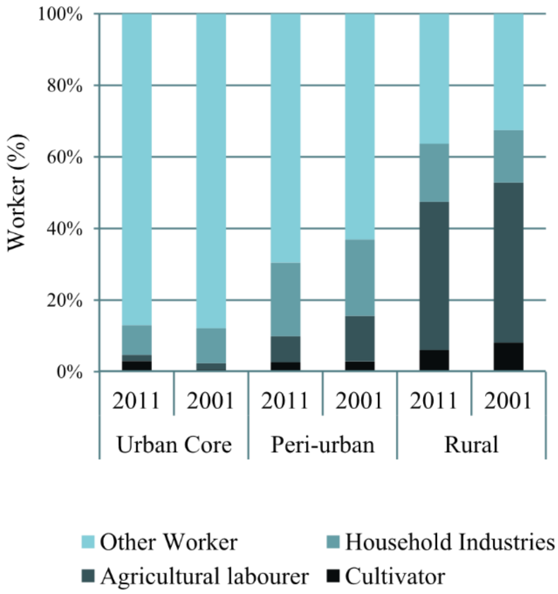


Figure 5. 15 : Workforce composition of marginal worker, 2001 - 11. Source: Prepared by the author

Even though the occupational pattern of the main worker has managed to remain relatively steady across the board from 2001 to 2011, a significant change is observed in peri-urban interfaces, where the share of cultivator and agricultural labourer has decreased in 2011 and the corresponding figure for other worker has increased (Fig.5.15). The reasons for this shift could be twofold: conversion of agricultural land to non-agricultural activities as cities expand spatially, resulting in the loss of agricultural livelihood on the one hand, and the rise of new wide and varied employment options in these transitional areas on the other. The occupational pattern of the marginal worker is similar to that of the main worker; however, the peri-urban areas show a sharp decline in agricultural labourer share in 2011 (5 percentage points) and a rapid increase in other worker, indicating the emerging short-term job opportunities in non-agricultural sectors in transitional spaces (Fig. 5.15).

From This study it is clear that the main concentration of urban fringe or Peri-urban area is located in KMA boundary. The Buffer area beyond KMA boundary is mostly rural.

5.4 Socio- Economical attributes of KMA:

5.4.1 Poverty Level in KMA area-an overview:

Poverty in the KMA is a difficult concept to grasp. This information comes from SUDA's survey of BPL households, which estimates that there are roughly 425,000 of them living outside of the Kolkata Municipal Corporation region, although it's not conclusive. With an average household size of 5-6 persons, this equates to about 2,350,000 people, or 30% of the entire population of 7,800,000, living on a salary that is insufficient to appropriately feed them (KUSP Design Team, 2003, Annex 1). When West Bengal reduced poverty from 55 percent in 1983 to 36 percent in 2010, it was a huge triumph (1993-94). In the years 1993/94, the estimated urban poverty rate was 22%. Despite this, the absolute level of urban poverty has risen. The most widely accepted definition of poverty is being unable to meet basic needs (BPL). In cities, it's the amount of money needed per person each month to consume at least 2,100 calories, or Rs. 415 (about US $10). After the implementation of SJSRY in 1997, the ULBs were expected to conduct a household survey to identify the BPL population and to identify the poorest among them. The first step of the BPL survey has not been completed in many municipalities, including Kolkata and Howrah Municipal Corporations. Most ULBs have not finished the second step, which aims to identify the poorest households in the BPL population in order to target the economic benefits of the SJSRY scheme. Each BPL household's priority rating is based on seven non-economic criteria, including living circumstances, access to water and sanitation, educational attainment, type of employment, and the presence of children. While councillors and Honorary Health Workers participated in the survey, SUDA offered financial and technical support. Whether or not the information is accurate is debatable. 9 Existing data may be 15-20% exaggerated. 10 The percentage of people living below the poverty line varies from 12% (in Chandannagore Municipal Corporation) to 58%. (Khardah municipality). The linguistic and ethnic diversity of the urban poor reflects previous migratory trends into the KMA. Refugees from Bangladesh are among them, as are migrants from rural West Bengal and neighbouring states, mainly Uttar Pradesh and Bihar, as well as ethnic minorities, primarily Muslims, who have long had ties to Kolkata. Unemployment and low income characterise the poor's circumstances, as does a deteriorated environment, a lack of basic services, and varied degrees of social marginalisation. For example, the United Central Refugee Council (UCRC) (for a more in-depth examination, see Dasgupta, 2000) represents refugees in various localities and can advocate for better service levels. Those who live in areas with irregular tenure, on the other hand, are the poorest and most vulnerable since they have no access to services and have no voice in the decisions that influence their daily lives. Pavement dwellers and people living in impromptu communities on property that had belonged to mills or government organisations, as well as people living along drainage canals, railway tracks, and beneath bridges, are examples of this population. They are disadvantaged because of their poor literacy levels, and they lack the understanding or aptitude to deal with the institutions set up to assist them.

The most blatant form of social exclusion has to do with one's job status. Tenure issues are prevalent among the poorest communities, accounting for about 10% of the total. People who have nowhere else to go and are unable to pay even the most basic of rentals live in these so-called slums. Many of these households are headed by single women, widows, or wives whose husbands are ill or disabled. There are no basic services provided because of their inconsistent funding, and the residents are frequently harassed as described in the report of the Kolkata Urban Services for the Poor. Non-Bengalis flocked from neighbouring states to work in the jute mills, and numerous destitute towns emerged as a result. The population of the KMA cities was further boosted by the migration of refugees from what was then East Pakistan in 1947 and the conflict in 1971. Refugees made hasty attempts to establish themselves on public, private, and railroad land, frequently in perilous circumstances.

5.4.2 Basic infrastructure and Housing condition in Peri-Urban areas of Kolkata Metropolitan Area:

Housing conditions and the sort of sewerage system in place are two of the most basic urban social services that must be provided. It has proven particularly useful to analyze overall situations in the varied space of the periphery, across districts in India, to use household data collected by the Census of India, provided at the lowest rural and urban level that is mouza and city/town correspondingly. For a comparative comparison across statutory towns, census towns, and rural areas within KMA, the same household asset data for a specific set was used in the research.

They are:

a. Condition of House.
b. Source of drinking water.
c. Presence of absence of latrine and type of associated sewer system or arrangements in absence of sewerage system.
d. Connection of wastewater drainage.

The core city of Kolkata, which is administered by the Kolkata Municipal Corporation, has been left out of the comparative data analysis for KMA's constituent unis. Due to the fact that the study focuses on the suburbs, KMC stands out as an outlier. In spite of being in rural administration, census town has an urban character, so the analysis would separate statutory towns, census towns, and rural mouzas. Piped water and sewerage systems, for example, are considered amenities that are primarily found in urban areas, although recent efforts have been made to bring some of these services to rural areas.

a. Condition of Housing

In the last few decades, numerous projects, particularly in the housing sector, have been implemented at the federal and state levels as well as in urban and rural areas. The state of West Bengal, specifically the KMA, is not an outlier. In fact, the agglomeration has experienced higher implementation rates of welfare schemes and recent missions than other parts of the state. Figure 5.16 shows that although there aren't many differences between good house conditions in the three categories, there has been a decline from statutory to rural areas that are purely rural.

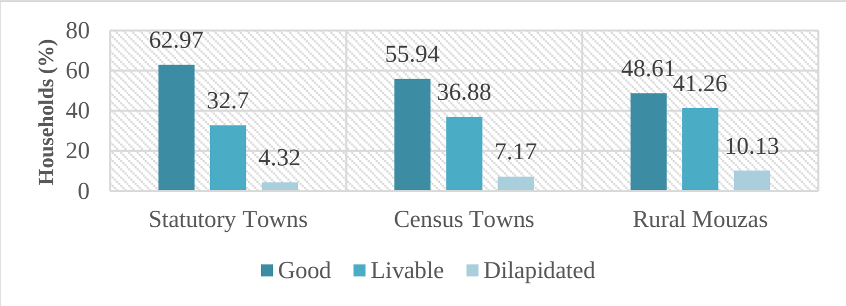


Figure 5. 16: Average Conditions of Houses in greater metropolitan area of Kolkata

Source: Computed by the author from H-14 table Census 2011.

b. Source of Drinking water

Tap water accessibility is critical when evaluating a city's liveability, regardless of whether it is a statutory or census-designated area. Rural areas that are part of a metropolitan area should have better access to basic services as a result of being part of a larger metropolitan area. The Department of Public Health and Engineering in West Bengal has played a major role in providing water to rural areas regardless of whether they are located inside or outside of the metropolis. In KMA, the Kolkata Metropolitan Water and Sanitation Authority (KMWSA) is in charge of water supply in the metropolitan area, although this service has primarily been provided in statutory urban areas. KMWSA[1] has recently begun supplying water to outlying areas of the KMA.

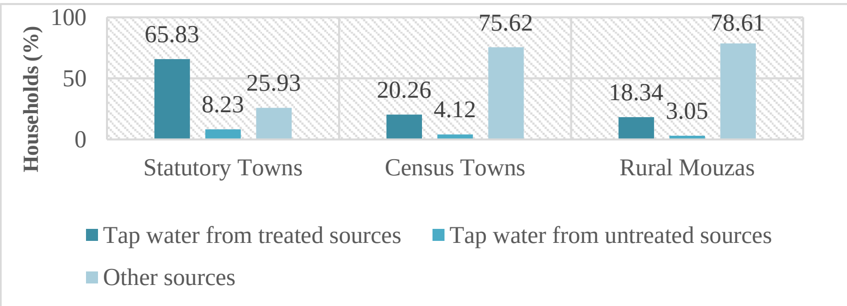


Figure 5. 17: Average Condition of Tap water Supply at household level in greater metropolitan area of Kolkata

Source: Computed by the author from H-14 table Census 2011.

Drinking water supply is one area where intra-metropolitan differences are obvious. While 74.06 percent of households in statutory towns have access to tap water (both treated and untreated), the availability percentage drops to 24.38 and 21.39 percent in census towns and rural mouzas, respectively. The distinctions between census towns and rural mouzas are not great. Despite the PHED's provision of water, most rural households still rely on hand pumps, boreholes, tube wells, springs, rivers, canals, and storage tanks, among other sources. These are the other resources. Hand pumps, for example, are the primary source of drinking water for 47.83 and 50.31 percent of households in census towns and rural areas, respectively, according to the Census 2011 H-14 table on household assets, while for statutory towns, the figure is closer to 29.5 percent. Even for many statutory towns, arranging water supply can be difficult on their own. The regional governance body is primarily responsible for providing assistance in this area.

c. Latrine Facility

It is a good indication of a city's basic quality of life if there is a latrine facility on the premises and what kind of sewerage runs through it. While it has long been considered an urban amenity, the construction of toilets within a premise is now strongly encouraged by various schemes, most notably the Swachh Bharat Mission (SBM).

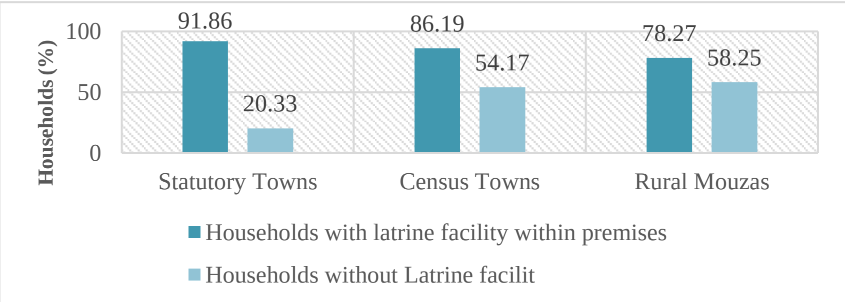


Figure 5. 18: Average Availability of Latrine facility within premise in greater metropolitan area of Kolkata

Source: Computed by the author from H-14 table Census 2011.

Figure 5.18 shows that on average in census towns within KMA, 86.19 percent of households have a latrine on site, which is not far behind Statutory towns (91.86 percent). Again, only 10.97 percent of statutory townhouses have 10.97 percent of piped sewer system, followed by the 60.97 percent of average households with septic tank (Figure 5.19).

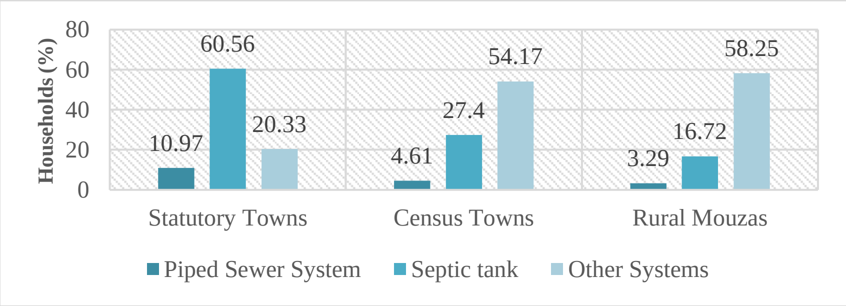


Figure 5. 19 : Average Availability of Piped Sewer system in greater metropolitan area of Kolkata
Source: Computed by the author from H-14 table Census 2011.

Census towns and rural mouzas have far worse access to a piped sewer system and a septic tank system. Other options, such as pit latrines, service latrines, night soil disposal, and so on, are more prevalent in census towns and rural mouzas. Most households in census towns and rural mouzas use concrete pit latrines, which account for 48.9% of all households (ibid.).

d. Waste water disposal

The type of waste water disposal used by statutory towns, census towns, and villages in peripheral KMA was the final parameter taken into account by the research. Closed drainage is used by only 21.34 percent of households in statutory towns, and 10.94 percent of households in census towns (Figure 5.20).

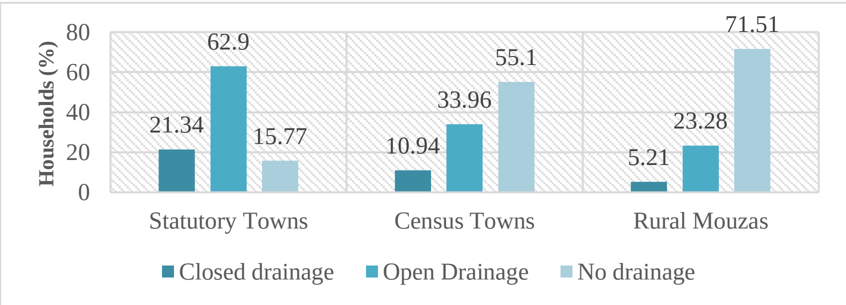


Figure 5. 20 : Average Waste water Disposal in greater metropolitan area of Kolkata

Source: Computed by the author from H-14 table Census 2011.

Statutory towns have higher percentage of open drainage while in census towns and rural mouzas Census towns and rural areas have higher percentages of average households without any drainage. In rural areas, the percentage is even higher: on average, 70.51 percent of households lack adequate drainage.

5.4.3 Transportation system: Available public transport like metro service sub urban rail connection

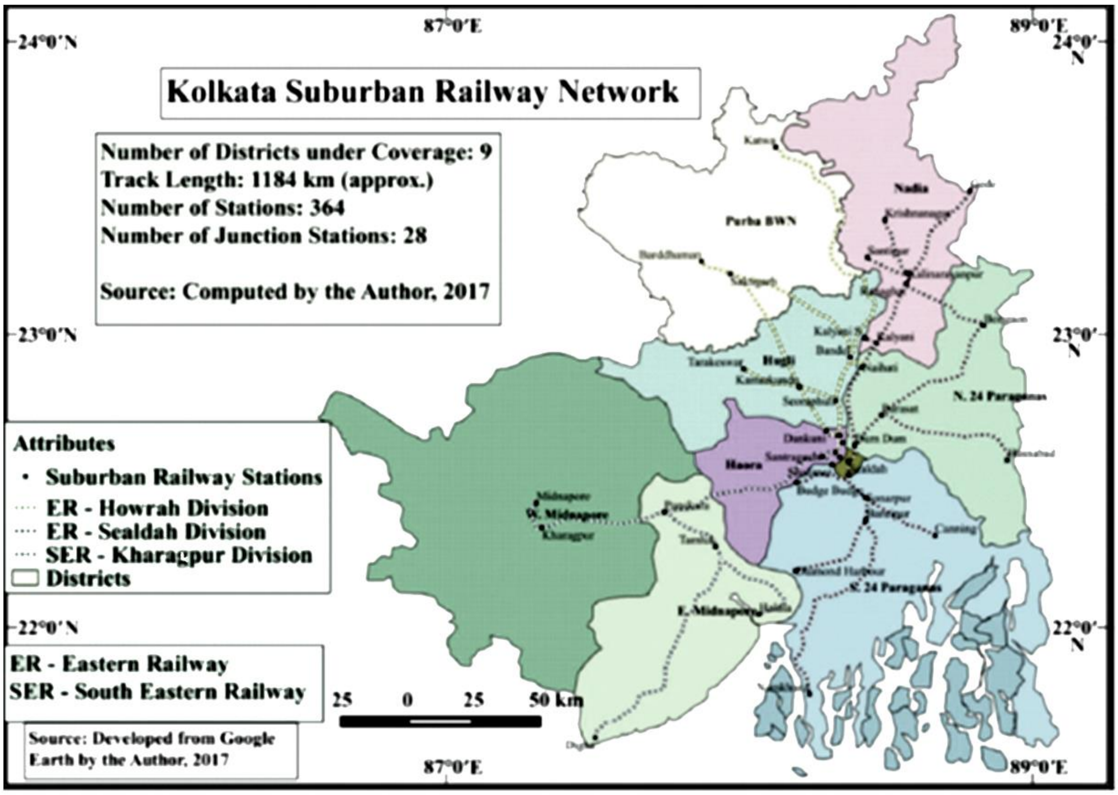


Figure 5. 21 : Kolkata Metropolitan Area -Connection with sub-urban areas with Railway Network
Source: Prepared by the author Based data available from Google Earth 2017

Kolkata's extensive suburban train network is the outcome of rising suburban passenger numbers during the 1960s. Because commuters make up the bulk of suburban passengers, suburban passenger data is used as a supplement to commuting data. The number of passengers is calculated based on ticket sales. Non-suburban commuters outnumbered suburban commuters until the 1960s. This was due to the fact that, up until then, railways had been built with the goal of connecting important raw material producing areas to the Kolkata market. However, after suburban train lines were electrified, passenger mobility skyrocketed. It popularized commuting. Suburban passengers accounted for more than half of all passengers in India in 1970, and this figure continued to rise until the turn of the twenty-first century (Mukhopadhyay, 2003). Between 1950 and 1990, suburban passengers climbed by 448 percent in India, whereas non-suburban passengers increased by only 83 percent. The increase in passenger kilometres has been identical, with suburban passengers' kilometres growing by 809 percent compared to 294 percent for non-suburban passengers. The Kolkata suburban train transports almost 1,700,000 commuters every day. The Eastern Railways are used by almost 90% of these commuters. Their numbers are growing every year, and the Eastern Railways are growing at a considerably quicker rate than the South-Eastern Railways. This is due to the Eastern Railways' longer route length (in kms). The Howrah division of Eastern Railways carries a section of the line along the Hugli River through the conurbations, connecting cities like Serampore, Seoraphuli, Chandannagore, and Bandel, which have a large number of people who work in Kolkata. Another section of Eastern Railways, administered by Sealdah division, connects cities such as Bongaon, Basirhat, Barasat, Hasnabad, Lakshmikantapur, Diamond Harbour, and Baruipur on the eastern and south-eastern outskirts of the metropolitan region. Several of these cities have sprung up along the Bangladeshi border. Large-scale immigration from Bangladesh has had a significant impact on the development of these cities since the partition. Because the new immigrants relied on Kolkata for their livelihood, the number of commuters increased.

The population in the peripheries of metropolitan areas rose at a considerably higher rate than the metro core areas, owing to the increased facilities required by commuting. The metro center of the KMA, which contains KMC and Haora MC, is experiencing diminishing population growth, while the periphery is experiencing higher growth, widening the gap between the two over time. (Karmakar, 2015). The importance of KMA's peripheral areas is shown by this core–periphery division. Between 1951 and 2011, the population density of the KMC increased by just 1.5 times, whereas the population density of Rajpur–Sonarpur town at the southern fringe increased by 31 times. Similarly, population density has increased more than 20 times and 17 times in North Dum Dum and Barasat, both in the eastern perimeter. In addition, numerous additional cities on the outskirts, such as Dum Dum, South Dum Dum, Kalyani, Panihati, Khardaha, Baruipur, and Baidyabati, have seen population density rise by more than 5 times. Because of their open expanses, low land values, lack of congestion, and pollution-free atmosphere, these newly urbanized places have emerged as valuable residential areas. Along with them, the most crucial reason was the ability to commute to the metro core while residing on the outskirts. Commuting has allowed for this dispersed urbanization. The size–class distribution of cities altered over time as a result of rising population size and density. In the 1951 census, there was no such thing as a class-I city among the post-independence cities. There are nine class-I cities on the list in 2011. Bidhannagar and Rajarhat–Gopalpur, for example, had experienced a population boom. Until 1981, Bidhannagar and Haldia were both classified as class–III towns. Within a decade, these two cities were elevated to the status of class–I cities, signifying a population increase of at least 50,000 people in each. In these outlying cities, land values have also increased significantly.

According to a survey done by a real estate company, land values in the northern fringes of Kolkata, such as Madhyamgram, along the Jessore Road and B. T. Road, as well as the Narendrapur–Baruipur area in the southern fringes, climbed by 150 percent in just three years, from 2007 to 2010. (Sen S. , 2011). Due to the exceptional rise in importance of the periphery, KMDA invests nearly equally in the core and the periphery in terms of planning expenditures.

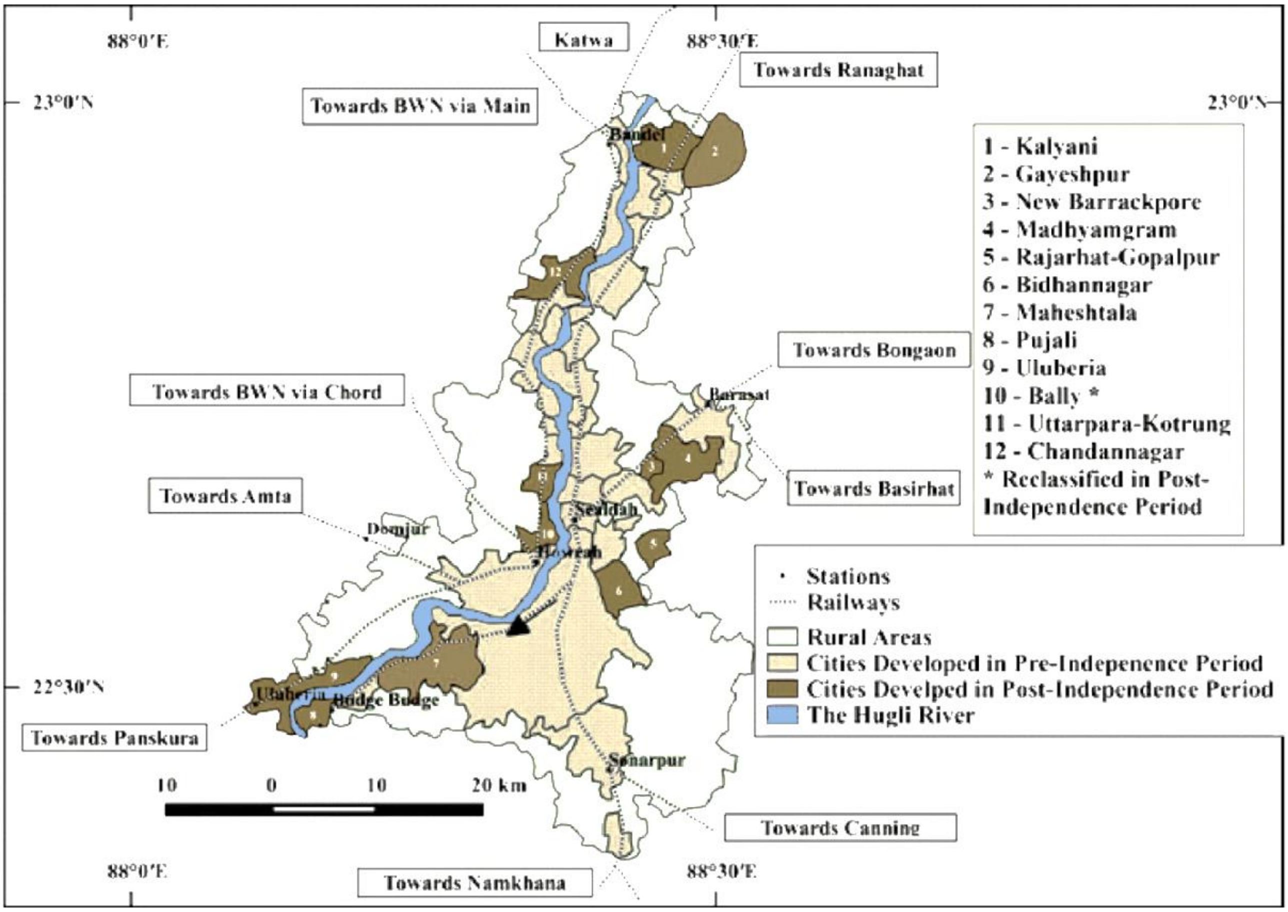


Figure 5. 22 : Transportation Network in KMA
Source: Composed by the author from database of Google Earth2017

5.5 Model 3: Weightage of indicators and Composite score analysis for Kolkata Metropolitan Area:

KMA is one of the country's oldest and largest agglomerations. The Calcutta Metropolitan Planning Organization (CMPO) used and developed the Land Control Act of 1965 to introduce the concept of Kolkata Metropolitan Area (formerly CMD, i.e. Calcutta Metropolitan District). According to this Schedule Act, the area of the then Calcutta Metropolitan District was 1380 km2, which has now grown to 1831.58 km2 (Table 5.6) in the deltas of the Hooghly River, covering the entire Kolkata district as well as parts of five other districts, namely 24Parganas (South), 24-Parganas (North), Howrah, Hooghly, and Nadia.

Table 5. 6: Composition of Kolkata Metropolitan Area: 2001 and 2011

	Categories of Area	Number in 2001	Area in Sq.km in 2001	Number in 2011	Area in Sq.Km in 2011.
1	Municipal Corporations	3	271.31	3	271.31
2	Municipalities	38	615.49	39	633.41
3	Non-Municipal urban(census) towns	77	200.10	75	193.98
4	Outgrowths	16	18.19	16	18.19
5	Rural Area	445	746.32	446	769.78
			1851.41		1886,67*

Source: 2001 data taken from CDP of Kolkata, Chapter 1, p. 1.
Note: Area expansion occurred in 2009

The Kolkata Metropolitan Development Authority (KMDA) established the boundary of this area, and the KMDA is in charge of all planning in this area. It is principally a development agency entrusted with the responsibility with carrying out significant infrastructure development within KMA (Kolkata Metropolitan Area). After nearly 51 years, KMDA is still the KMA's authority for urban planning and development. One of the most distinguishing features of this well-known metropolitan area is that it is surrounded by rural areas.

In previous spatial analysis fringe areas has been earmarked/separated from regional rural backdrop. According to the findings, there are a few common features that might be used as indications of urban influence on the outskirts. As a result, such criteria are employed as variables to determine the saturation level and land potential in the Peri Urban Area for planned development (PU:C1, PU:C2). The variables are broadly classified as demographic features, Land use Feature and availability of public services.

5.5.1 Demographic Feature: Population density:

One of the appropriate metrics for gauging the city's influence is population density. Both skilled and unskilled population either migrates or commutes to this metro city for education, employment and other utility services but resides at this fringe due to availability of affordable housing. Identifying and projecting this sub urban population is required to calculate housing and other infrastructure demand. Absence of inclusive planning results in haphazard growth, Formation of slum etc. In this section the density and growth rate of entire KMA area has been analysed for past three decades. The density varies from 300 ppl/Sq.Km. to more than 24000 ppl/ sqkm. From Study it has been found after attaining 18000 ppl/ sqkm of density the population growth rate starts reducing. So, for composite score analysis area having density > 18000 ppl/sqkm given 1, From 6000-18000ppl/sqkm given 2, less than 6000ppl/ sqkm density has been given as 3. Fig 5.23 shows census year wise population increase as well decadal growth for 1991-2001 and 2001-2011 census years.

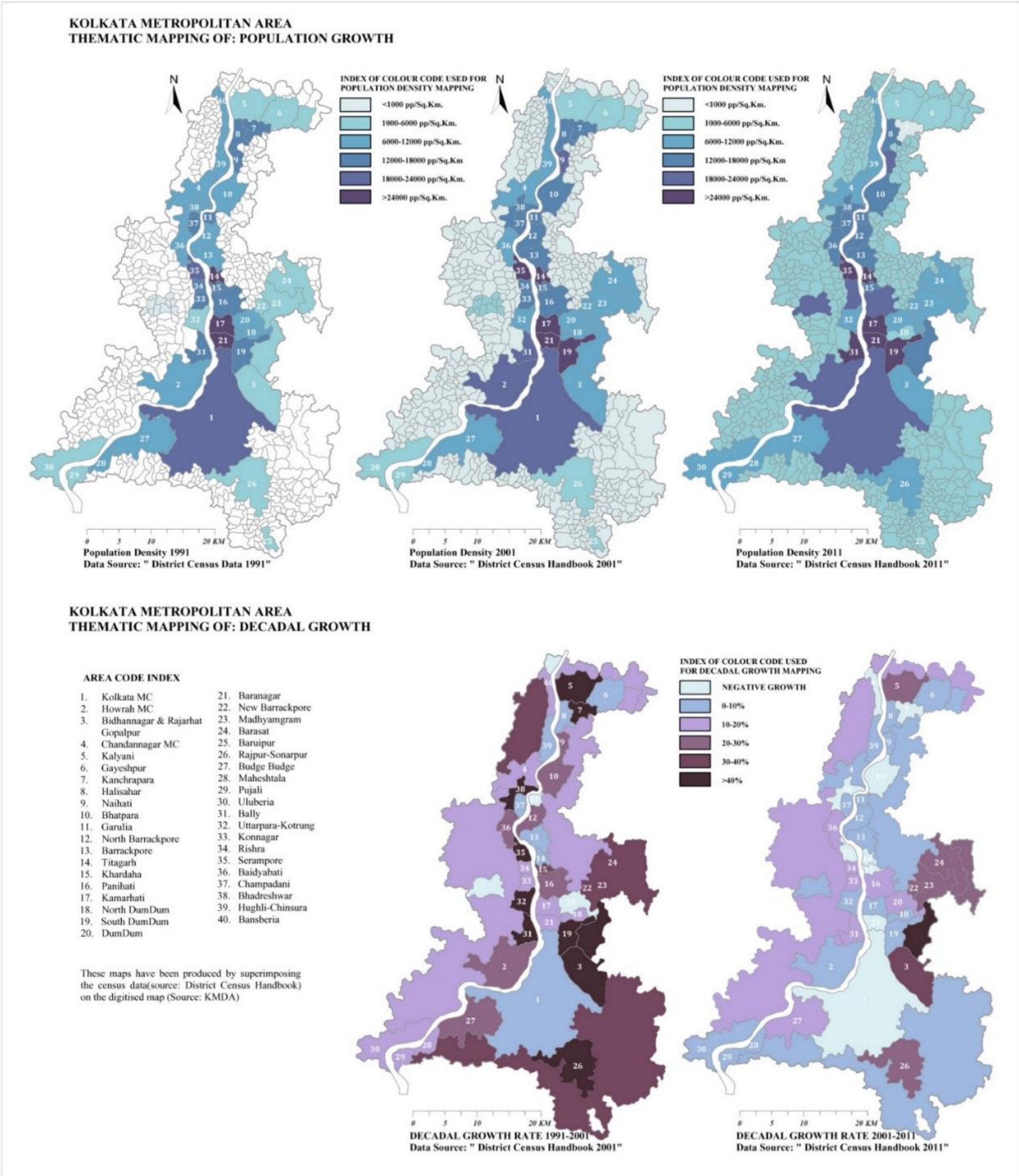


Figure 5. 23 :Kolkata Metropolitan Area -Thematic mapping – Population Density and decadal Growth
Source: Prepared by the author Based on Decadal census

5.5.2 Demographic Feature: Decadal growth of KMA area:

In the last 50 years, the different geographical constituents of the KMA have experienced different rates of urban growth and this is shown in Table 2. The core area comprising the KMC, with its higher population density, has clearly stagnated with its 2001–2011 growth rate of –1.67 per cent being the lowest of all the million-plus population cities in the country. The KMA's smaller municipal towns, on the other hand, have grown steadily but slowly during the last decade.

The cumulative growth rate for the KMA municipal towns, like the core area, conceals significant variations in growth. In the last decade, the population of municipal towns grew at a rate of around 0.64 percent per year, with wide variations. Negative growth rates have been recorded in nine of the 39 towns, namely Kanchrapara, Bhatpara, Titagarh, Khardha, Baranagar, Bansberia, Bhadreshwar, Serampore, and New Barrackpore. The ongoing decline of the jute industry, as well as a lack of economic opportunities in the organised sector, have undoubtedly played a role. During 2001–2011, the municipal towns of Rajarhat-Gopalpur, Bidhan Nagar, and Rajpur-Sonarpur had the highest growth rates of 3.25 percent, 2.38 percent, and 2.06 percent per year, respectively, on the eastern side of the metropolitan area, reflecting the development and construction activities associated with the newly emerging planned satellite city, New Town (Rajarhat), and that along the southern end of the Eastern Metropolitan Bypass.

Table 5. 7 : Decadal Rate of Population Growth in Kolkata Metropolitan Area

	1981-1991	1991-2001	2001-2011
KMA Local Body municipal bodies	2.92	2.69	0.64
Kolkata Municipal Corporation	0.63	0.41	-0.16
Howrah Municipal Corporation	2.72	0.60	0.64

Source: Based on data taken from Census of India 2011: Population Finder on website Cennsusindia.gov.in, Growth rates for the year 1981-1991 to 1991-2001 taken from CDP for Kolkata prepared by KMDA(2007.P11)

Table 5. 8 : Decadal population growth rate in core and peri-urban areas of KMA

Year	Core	Peri-Urban	Difference
1981-1991	0.64	1.72	1.08
1991-2001	0.40	1.82	1.42
2001-2011	-0.19	1.09	1.28

Source: (Karmakar, 2015)

The change in land-use and land-cover is primarily driven by population growth, which results in residential land expansion from the city to the outskirts. The stagnation of the core city and the dispersal of the population to the suburbs are not unique to Calcutta (Giri & Bhaduri, 1993). The number of high-density towns increases dramatically, from one in 1951, 1961, and 1971 to six in 1981. In addition, the number of high-density towns increased from 7 in 1971 to 12 in 1981. (Chatterjee, 2008). Figures 5.24, 5.25, and 5.26 depict the rates of growth of various Municipal Corporations and Municipalities in KMA. Maximum population growth occurred in Howrah

Municipal Corporation (HMC) and Chandannagar Municipal Corporation between 1991-2011. Among the municipalities, Bidhannagar has seen the most growth during this time period. This is due to the abundance of job opportunities and the desire to live closer to Kolkata. Aside from that, the municipalities of Uluberia and Khardaha have experienced rapid growth. During the period 1991–2001 (Fig. 5.24, 5,25), Rajpur Sonarpur and Pujali municipalities experienced the highest population growth in this city's outskirts. This is due to its accessibility from Kolkata city and industrial growth, which has aided in its growth. The Metro Railways were put into service in the 1990s, and some towns near Dumdum and the Garia–Sonarpur region reaped the benefits. There has been an organised real estate boom as a result of the fast transport system, which has accelerated population growth in the surrounding area (Chatterjee 2008). However, from 2001 to 2011 (Fig. 5.26), it can be seen that Kolkata Municipal Corporation (KMC) experienced negative growth for the first time in its history. The two important adjudication municipalities, Rajarhat Gopalpur and Bidhannagar, experienced high population growth among the other municipalities. This is due to the fact that Kolkata city has recently become completely saturated, resulting in a lack of open spaces and high land prices in city core areas, which encourages people to relocate to the periphery. However, a few municipalities, including Bhadreswar, Hooghly-Chinsurah, Budge Budge, New Barrackpore, and Baranagar, have experienced negative population growth rates. The most likely cause is the closure of jute industries and a lack of job opportunities in these areas. Concentration of population is a useful statistical tool for determining the nature of urban growth.

The concentration of urban population can be expressed as a percentage of total urban population divided by the percentage of urban population. The *H* index was used to calculate the concentration of urban population.

$$H\ index = S(P_i/P_t)$$

where H denotes the concentration of urban population, P_i denotes the urban population of any urban centre, and P_t denotes the total urban population of the region. Value of the same is counted between 0 and 1 (Basak, 2009).

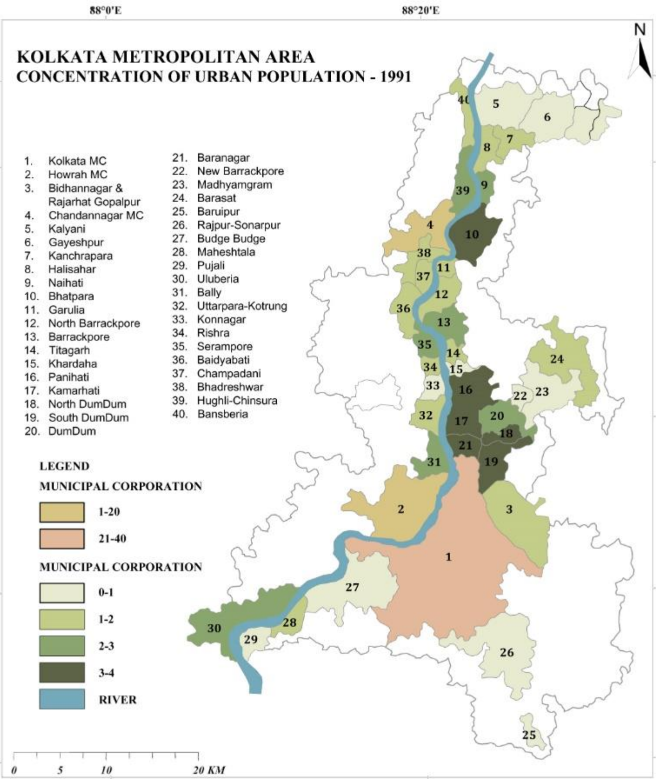


Figure 5. 24 : Kolkata Metropolitan Area - Concentration of urban population 1991
Source: Prepared by the author Based on Decadal census

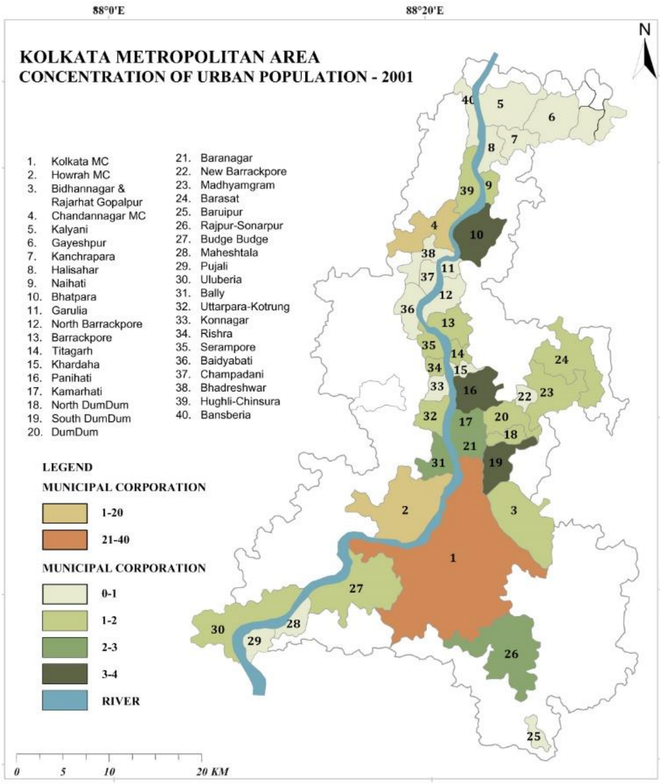


Figure 5. 25 : Kolkata Metropolitan Area -Concentration of urban population 2001
Source: Prepared by the author Based on Decadal census

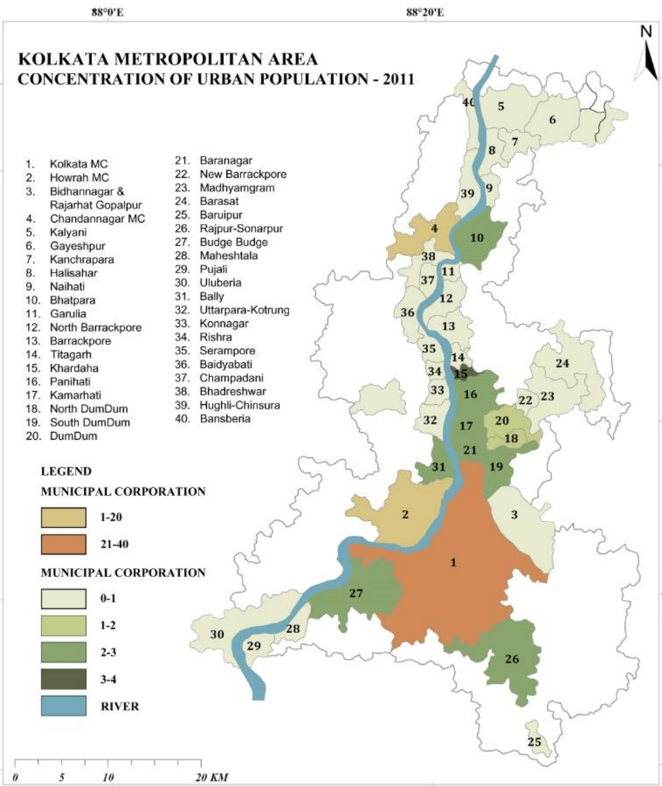


Figure 5. 26: Kolkata Metropolitan Area - Kolkata Metropolitan Area -Concentration of urban population 2011

Source: Prepared by the author Based on Decadal census

Figures 5.24, 5.25 and 5.26 depict the urban population concentration of the KMA from 1991 to 2011. The population concentration in KMC areas was high in 1981. KMC accounted for approximately half of KMA's urban population in 1981, followed by HMC, Uluberia, and Bhatpara(source:censusdata1981). In the years 1991 and 2001 (Figs. 5.24 and 2.25), the populati on concentration of KMC decreased by 5% and 9%, respectively. Between 1991 and 2001, the population of HMC fell by nearly 1%. Only a few municipalities, such as Bally, Uluberia, Pujali, Rajpur Sonarpur, Bidhannagar, Dumdum, Madhyamgram, Kalyani, and North Dumdum, saw increases in urban population concentration from 1991 to 2001. Following the 2011 census, the Joka I and Joka II gramme panchayats of the South 24 Parganas district were added to the KMC, and later, some areas of the Haringhata blocks of the Nadia district were added to the KMA. The urban population concentration in KMC has decreased by 3% as a result of this addition. Other municipalities with positive population concentration growth rates include Rajpur Sonarpur, Baruipur, Madhyamgram, Barasat, Kalyani, and North Dumdum. The urban concentration may be due to its proximity to Kolkata and ease of access. According to the figures in Figures 2.6 and 2.7, the population density in KMA increased from 2001 to 2011. Titagarh municipal area had the highest population density in 2001 (Fig. 5.25), and it is the only area in the northern sides of KMA on the eastern sides of the river Hugli that has experienced high density due to industrialisation. This is followed by the areas of Baranagar, Kamarhati, South Dumdum, and KMC. The map (Fig. 5.26) depicts the current population density (2011 Census) of various urban units in KMA, which was calculated after the addition of two gramme panchayats in KMC. According to the 2011 Census, Titagarh municipal areas have the highest population density, followed by Baranagar, Kamarhati, South Dumdum, and KMC areas. Because of spatial reorganisation, the area of some municipalities was increased during this time period, and contiguous rural areas were incorporated into the former municipalities (Chatterjee, 2008). Joka I and Joka II gramme panchayats in South 24 Parganas district were added to KMC after 2011. As of now, the total number of wards in KMC is 144. Dankuni municipality was introduced by the KMDA in the 2011 Census, with a total area of 19.36 km2. Since the last ten years, KMA has seen a significant increase in the demand for land. Land prices in various parts of the KMA have risen rapidly in recent decades. The causes of this huge variation in land price are the extension of the metro railway from Dumdum to Noapara, the extension of the EM Bypass from Kamalgazi to Baruipur, the development of various new real estate projects, and the improvement of connectivity due to the availability of cabs, private buses, and CSTC buses. By careful observation, it is clear that the majority of residential apartment construction occurs in the Barasat–Madhyamgram area for a variety of reasons, including good connectivity, the presence of vacant land, relatively low land prices, and proximity to Kolkata city, among others. According to the findings of the field verification, good connectivity from other areas as well as the airport is critical for the city's development. As a result, the majority of residential development is concentrated in the Barasat–Madhyamgram as well as Garia-Baruipur areas. Another notable feature is that land prices (refer section 5.5.4) in Kolkata's north-eastern outskirts are lower than in other parts of the city. According to the above databases, the price of land primarily for residential purposes is relatively low in the KMA's north-eastern, south-eastern region. Land prices are quite high in the northern part and core city area, i.e. near Laketown and VIP road areas due to good connectivity via VIP road and proximity to the airport and Ruby-Mukundapur due their linkage with the Bypass. However, the price of land in Kolkata's northern-southern outskirts is lower than in the rest of the city. The relatively low cost of land attracts people from lower-income groups to relocate to these areas for residential purposes. It is also worth noting that land prices near the Sodepur–Madhyamgram, E.M. Bypass road are higher than in other areas of Kolkata, owing to the approval of a metro railway line to Dakhineswar and Barrackpore. From 1991 to the present, the mean population centre has shifted to the north-eastern south-eastern side.

5.5.3 Builtup Density

Proportion of built-up area of a particular unit to total unit area in its percentage figure was indicated as the built-up density of any urban area. In 1990, the highest built-up density is identified in Bally (87.85%) followed by Baranagar (76.55%) and Dumdum (75%) whereas the lowest in Barrackpore (4.4%). During the mentioned 20-year time span, all the 42 units experienced significant positive increase in builtup area. In 2011, the highest built-up density is identified in Dumdum (97.67%) followed by Bally (96.5%) and South Dumdum (95.92%) whereas the lowest in Uluberia (19.20%). So, the highest value of built-up density almost reached cent percent, and the minimum threshold also increased significantly. Maximum change in built-up area occurred in case of North Dumdum (46.44%) followed by Rajarhat (38.3%) and North Barrackpore (28.54%). From the spatial output in 1991, area under 60% built-up has been concentrated around the two major urban cores of Kolkata MC and Howrah MC where only Bally Municipality crosses the limit and recorded more than 80% built-up area (Fig. 5.27). After 20 years the scenario has changed drastically where the previous occupied area adjoining to Kolkata MC and Howrah MC has crossed the 80% built-up area. In the northern part of the study area, Hooghly-Chinsurah Municipality also recorded 83.65% built-up area as well as area under lowest record (< 20%) of built-up area only limited to Uluberia municipal area (Fig. 5.27)

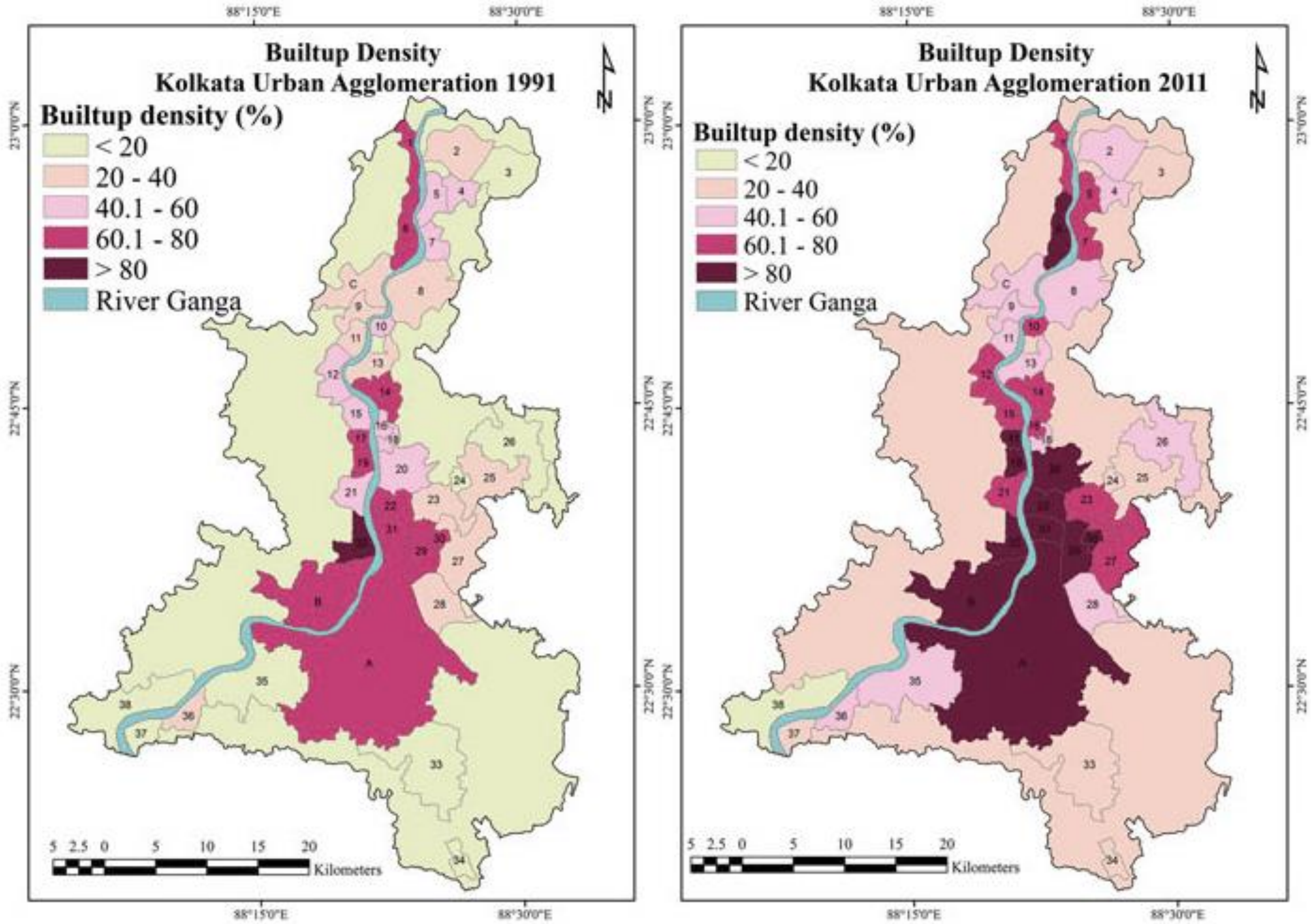


Figure 5. 27 : Built-Up Density mapping of Kolkata Metropolitan Area-1991-2011
Source: Composed by the author from database of Landsat data, KMDA, SOI Data

Identifying 4 Saturated and Non-Saturated Areas based on Urban Density calculated on LULC mapping of the area of KMA in 2021 shown in Fig.5.28

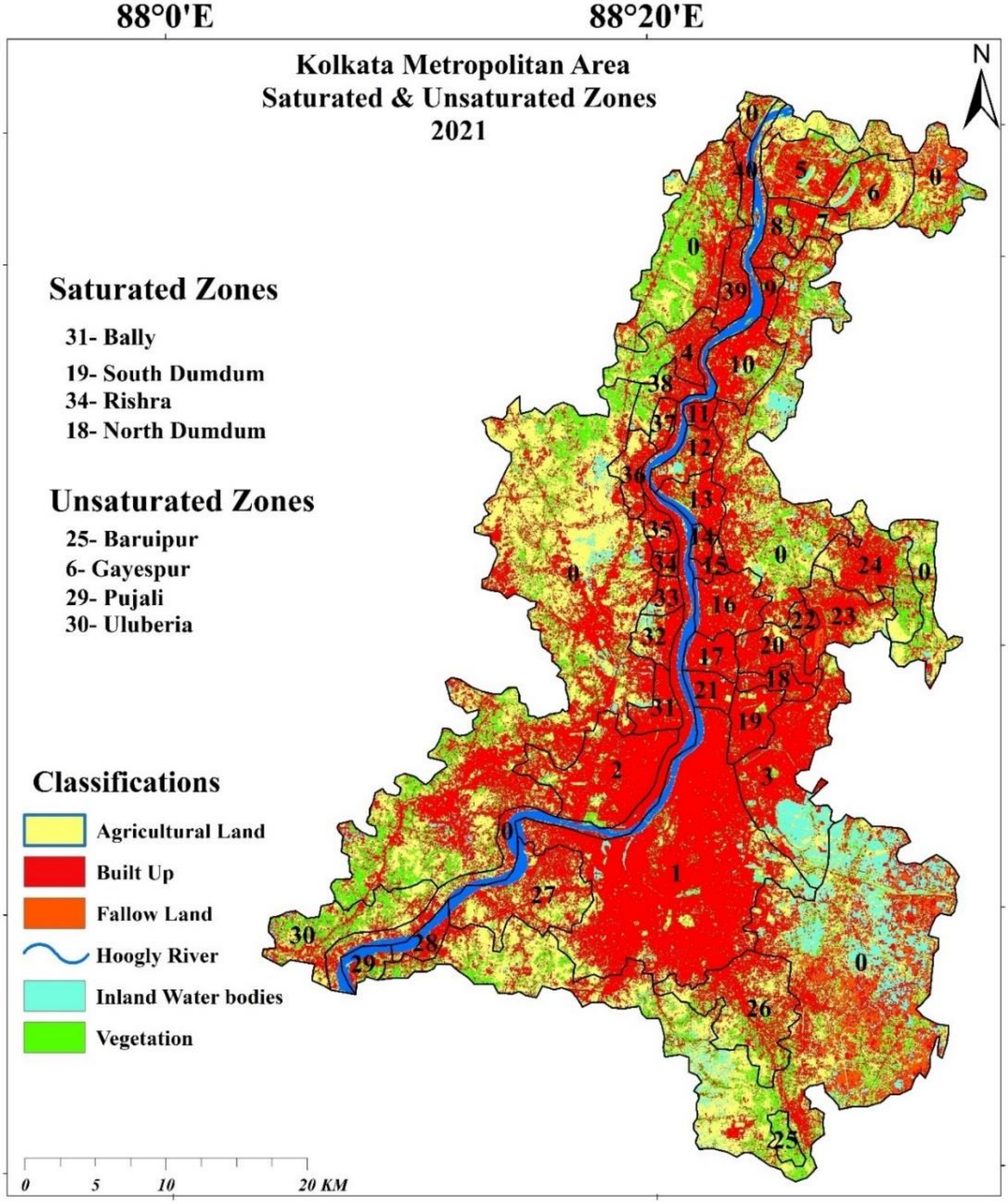


Figure 5. 28: Kolkata Metropolitan Area-marking of zone with land development potential from LULC and Built-Up Density Calculation
Source: Composed by the author from database of Landsat data, KMDA, SOI Data

5.5.4 Land use Feature: Land price:

The data for this section has been collected from secondary Data source: "An assessment of housing affordability inclusive of variations in infrastructure development within a metropolis: case of Kolkata" -PhD thesis report by Ankhi Banerjee, IIT, Kharagpur. The housing market is found to be affordable for housing unit size of 300 square feet by inclusive affordability measure all over KUA (refer 5.29). Housing unit sizes of 600 square feet are found to be seriously unaffordable in core and parts of central sub-regions, and moderately affordable in periphery sub-regions.

Observations on housing affordability

- The high proportion of transportation costs in household expenditures highlights the need for an inclusive measure of housing affordability. The most likely solution to meet the housing needs of LMIG or Aspirers is to provide rental housing with unit sizes of 400 square feet near mass transit corridors. These people have a harder time evaluating housing options than people in higher income groups.
- House prices falling from central to periphery indicate that affordable ownership housing is more readily available in both central and peripheral sub-regions.
- KUA has a wide range of infrastructure development, with the core sub-region being the most advanced. There must be onsite infrastructure such as water supply and offsite infrastructure such as educational and healthcare facilities throughout KUA to improve the basic standard of living. Infrastructural development has a strong correlation with the housing affordability index, but it does not appear to have a negative impact on the availability of affordable homes for rent.

Observations on future housing location choice

- When it comes to residential location selection in a developing nation, households prioritise proximity to basic physical infrastructure, such as water, sewage, and electricity. Existing low level of basic on-site and off-site infrastructure development is underlined by the priority given to water supply and educational centers in households' choice of residential relocation.
- According to the expected infrastructure development levels across KUA, households prefer to live in core sub-regions more than anywhere else in KUA. This contrasts with the actual differences between core and non-core KUA residential locations. This implies that if infrastructure development levels vary less in the future, housing demand in core regions will be eased..

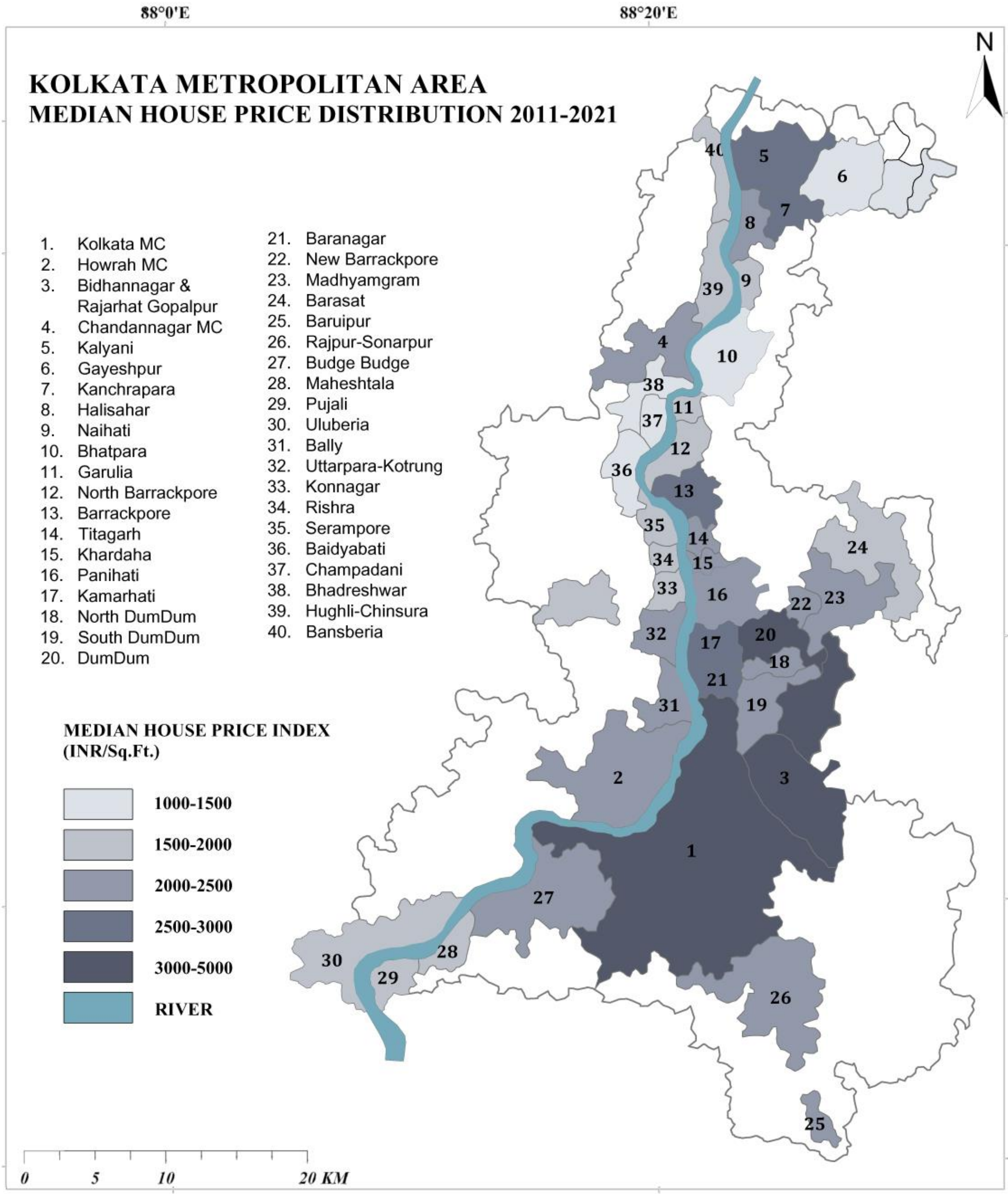


Figure 5. 29 : Kolkata Metropolitan Area -Thematic mapping – Median House Price Distribution

Table G6: House price distribution across KMA .Source: A.B. Thesis, IITKGP

Table 5. 9 : Preferred residential location in KMA					
	Global priority weight for				
Sub-region	relocation near core	relocation slightly near core	no relocation	relocation slightly near periphery	relocation near periphery
Core East	0.34	0.23	0.23	0.12	0.08
Core West	0.33	0.19	0.25	0.13	0.10
Central East	0.37	0.21	0.21	0.12	0.09
Central West	0.35	0.20	0.21	0.14	0.10
Periphery East	0.37	0.21	0.21	0.13	0.09
Periphery West	0.34	0.20	0.22	0.15	0.09
KUA	0.35	0.21	0.22	0.13	0.09
Source: AHP survey, Table H31 in Appendix H. A.B. Thesis, IITKGP					

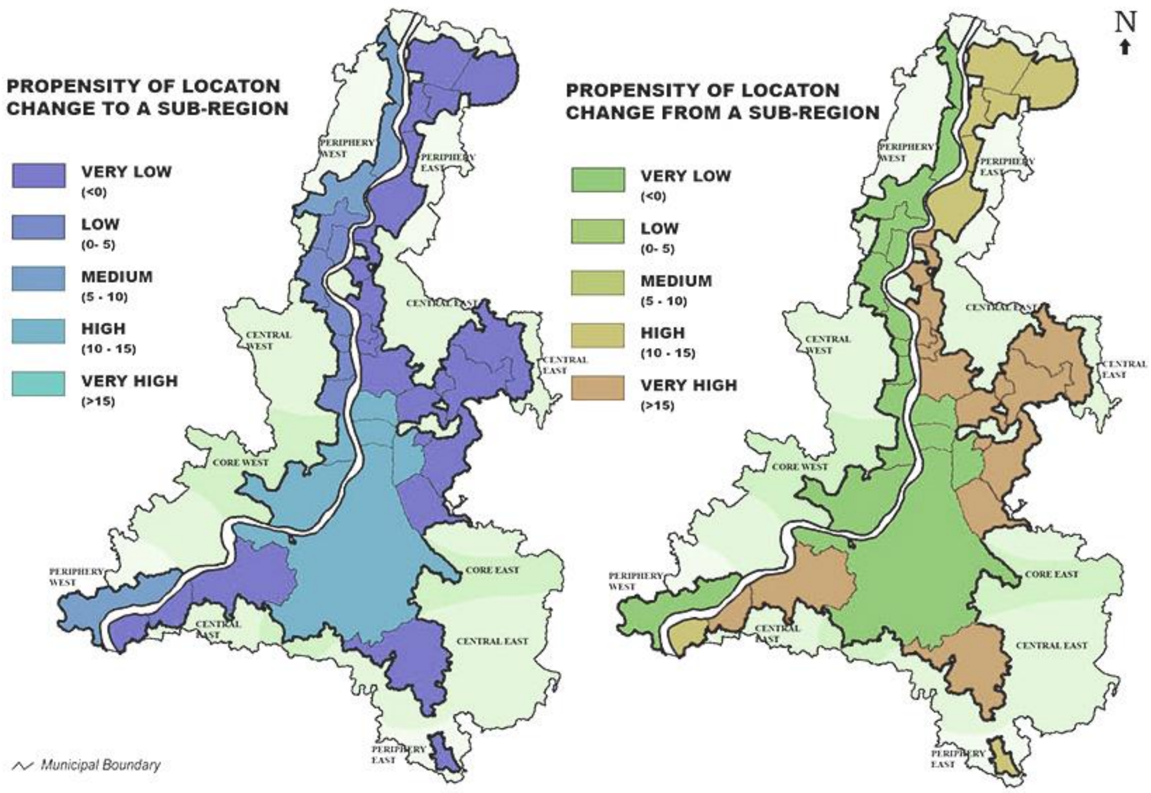


Figure 5. 30 : Kolkata Metropolitan Area -Thematic mapping – Propensity
Source: A.B. Thesis, IITKGP

From This research the pockets earmarked as affordable of 600 sqft unit size has been given score 2, moderately unaffordable pockets given score 1. In Severely unaffordable pockets the residential built up likely to change its behaviour/ land use pattern and may emerge as mixed use or commercial area. These pockets are highly urbanized, saturated. So, the land potential score has been given 0 to this area.

5.5.5 Density: Distance from the city centre/CBD:

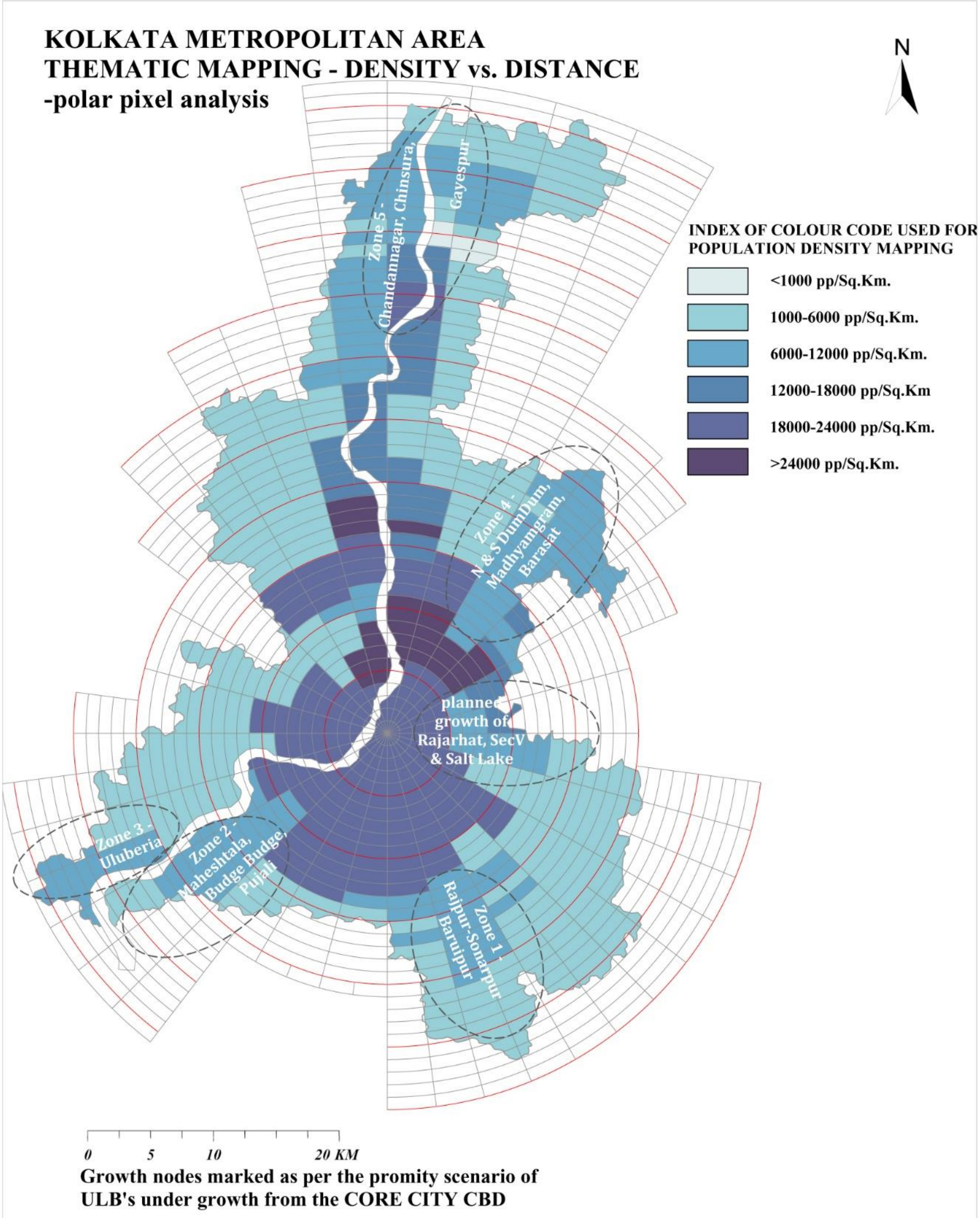


Figure 5. 31 : Kolkata Metropolitan Area -Density and Distance mapping zone identification.
Source: Prepared by Author

It is evident from the study that the effect of urban centre reduces with the distance mostly in terms of travel time distance. So, distance from CBD also plays a premium role. To Study this, few CBDs has been identified. Almost 90 % work trip has destined to this CBD. From Waited analysis few potential zones are identified.

Locational preference of these zones has been analysed through its travel time distance from different 'Trip Attraction Node' that is main commercial-institutional nodes, Intercity Railway, Bus terminals, airport etc.in KMA. To understand the comparative importance of these nodes and to assign their weightage, a sample survey of different age group people from different income group has been done to know average number of visits to these nodes per year. Assigned weightage has been shown in Table 5.10.

Table 5. 10 : Weightage of Different CBD according to their Importance:

CBD/Transport Node	Weightage
CBD(BBD Bagh, Esplanade)	2.4
Howrah	0.1
SealDah	0.05
Kolkata	0.02
Airport (NSCI Airport, DumDum)	0.01
Sector-V, New Town	2.4
Source : Author	

The weighted Sum of the travel time to these nodes from each zone has been calculated. The zone having lower value has higher degree of locational preference hence higher potential to grow. From this analysis the micro level study area or the model areas are chosen from the following Table: 5.11

Table 5. 11 : Weighted Time Distance Relationship for Zones with Growth Potential

Time Distance Relationship	CBD (BBDBag, Esplanade)	Howrah	Sealdah	Kolkata Station	NSCI Airport, DumDum	Sector-V, New Town	Weighted Total	
	Travel Time (Min.)							**Rank**
Zone 1 - Rajpur-Sonarpur, Baruipur	68.22	52	50	57	65	50	293.218	2
Zone 2 - Maheshtala, Budge Budge, Pujali	50	55	55	65	100	70	298.55	4
Zone 3 - Uluberia	50	45	55	65	55	70	297.1	3
Zone 4 - N&S DumDum, Madhyamgram, Barasat	45	45	50	35	20	40	211.9	1
Zone 5 - Chandannagar, Chinsura, Gayespur	70	60	70	65	60	80	371.4	5
Source: computed by author								

5.5.6: Composite weightage analysis and identification of potential unsaturated and saturated zones within KMA

The composite weight analysis has been done based on scoring for the following criterions.

Population Density: Study of density profile over decades in Kolkata Metropolitan Area reveals – after attaining 18000 pp/ Sq. Km. density the rate of growth starts reducing. These pockets are given 1 score, gradually score 2, 3 are given for those areas which have potential to grow.

Land availability: Land use analysis from land sat data shows the area having 60- 80% of built up density areas are fully saturated hence score 1 is given. Wet lands, dense agricultural area, rivers are given 0 score as urbanisation should be restricted over these areas. Rest other areas are given score 2 or 3 based on their built-up density.

Land price: Housing size and their price are considered as the indicator of land price. From study it is evident that highly saturated area has higher price of land. Also planned town ships like New Town Rajarhat Kolkata which may hold high density population also has higher rate of land price.

For this, secondary data source has been adopted from PhD research in the department of planning of IIT Kharagpur. From This research the pockets earmarked as affordable of 600 sqft unit size has been given score 2, moderately unaffordable pockets given score 1. In Severely unaffordable pockets the residential built up likely to change its behaviour/ land use pattern and may emerge as mixed use or commercial area. These pockets are highly urbanised, saturated. So, the land potential score has been given 0 to this area.

Based on this calculation in the next table no 5.12 micro level pocket areas with development potential have been selected therefore.

Table 5. 12 : Weighted analysis of municipal corporation and municipalities in KMA

		Population density >18000=1 6000-18000=2 <6000=3	Land Availability	Land Price	Total
	Municipal Corporation				
	Kolkata	1	0	0	1
	Bidhannagar	1	1	0	2
	Howrah	1	1	0	2
	Chandannagar	1	1	1	3
	Municipalities				
North 24 Parganas district	Baranagar,	1	1	0	2
	Barasat	2	1	0	3
	Barrackpore	2	1	1	4
	Bhatpara	2	1	0	3
	Dum Dum	1	1	1	3
	Garulia	2	2	1	5
	Halisahar	2	1	1	4
	Kamarhati	2	1	1	4
	Kanchrapara	2	1	1	4
	Khardah	2	1	1	4
	Madhyamgram	1	1	1	3
	Naihati	2	1	1	4
	New Barrackpore	2	1	1	4
	North Barrackpur	1	1	1	3
	North Dumdum	1	1	1	3
	Panihati	2	1	1	4
	South Dumdum	1	1	1	3
	Titagarh	1	1	1	3
South 24 Parganas	Baruipur	3	2	2	7
	Budge Budge	3	2	1	6
	Jaynagar Majilpur	3	2	2	7
	Maheshtala	3	2	2	7
	Pujali	3	2	2	7
	Rajpur Sonarpur	2	1	1	4
Howrah	Uluberia	3	2	2	7
	Bally	1	1	0	2
Nadia district	Gayeshpur	3	2	2	7
	Kalyani	2	1	1	4
Hooghly district	Baidyabati	2	1	1	4
	Bhadreswar	2	1	1	4
	Bansberia	2	2	1	5
	Champdani	2	1	1	4
	Dankuni	2	1	1	4
	Hooghly-Chinsurah	3	2	1	6
	Konnagar	2	1	1	4
	Rishra	3	1	1	5
	Serampore	2	1	1	4
	Uttarpara Kotrung	3	1	1	5

Source: Computed by author

Following zones are identified as unsaturated areas with land development potential:

Zone 1: Baruipur, Jaynagar

Zone 2: Maheshtala Budgebedge, Pujali

Zone 3: Uluberia

Zone 4 : Hoogly Chuchura

Zone 5: Gayeshpur

Identifying 4 no's of Non-Saturated Areas based Weightage calculated based on population, LULC, land price index of the area of KMA in 2021 shown in Fig.5.32

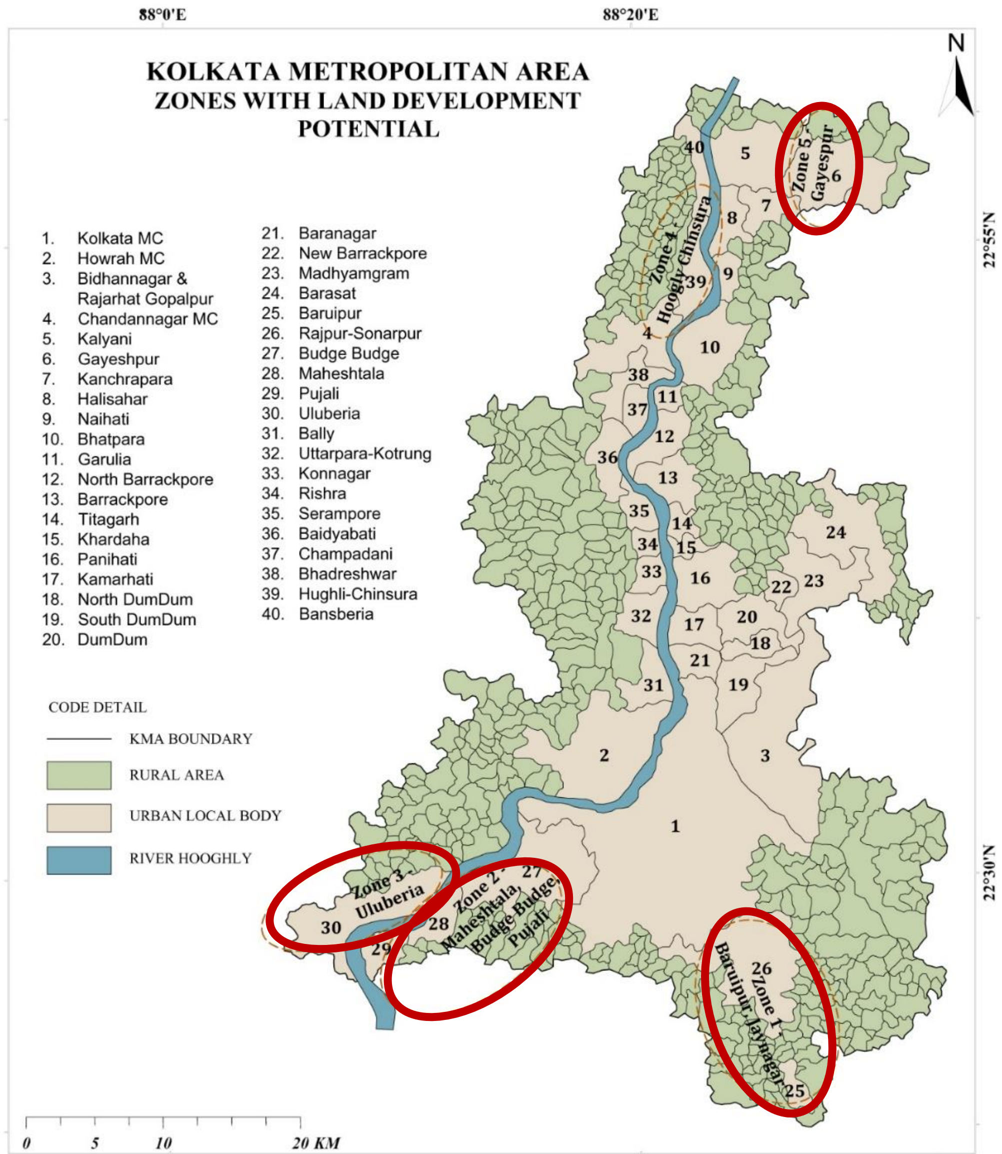


Figure 5. 32 : Kolkata Metropolitan Area -Identifying Non-Saturated Zones.
Source: Prepared by Author

5.6 Infrastructure: Road connectivity & Availability of Sub urban rail/ Metro service:

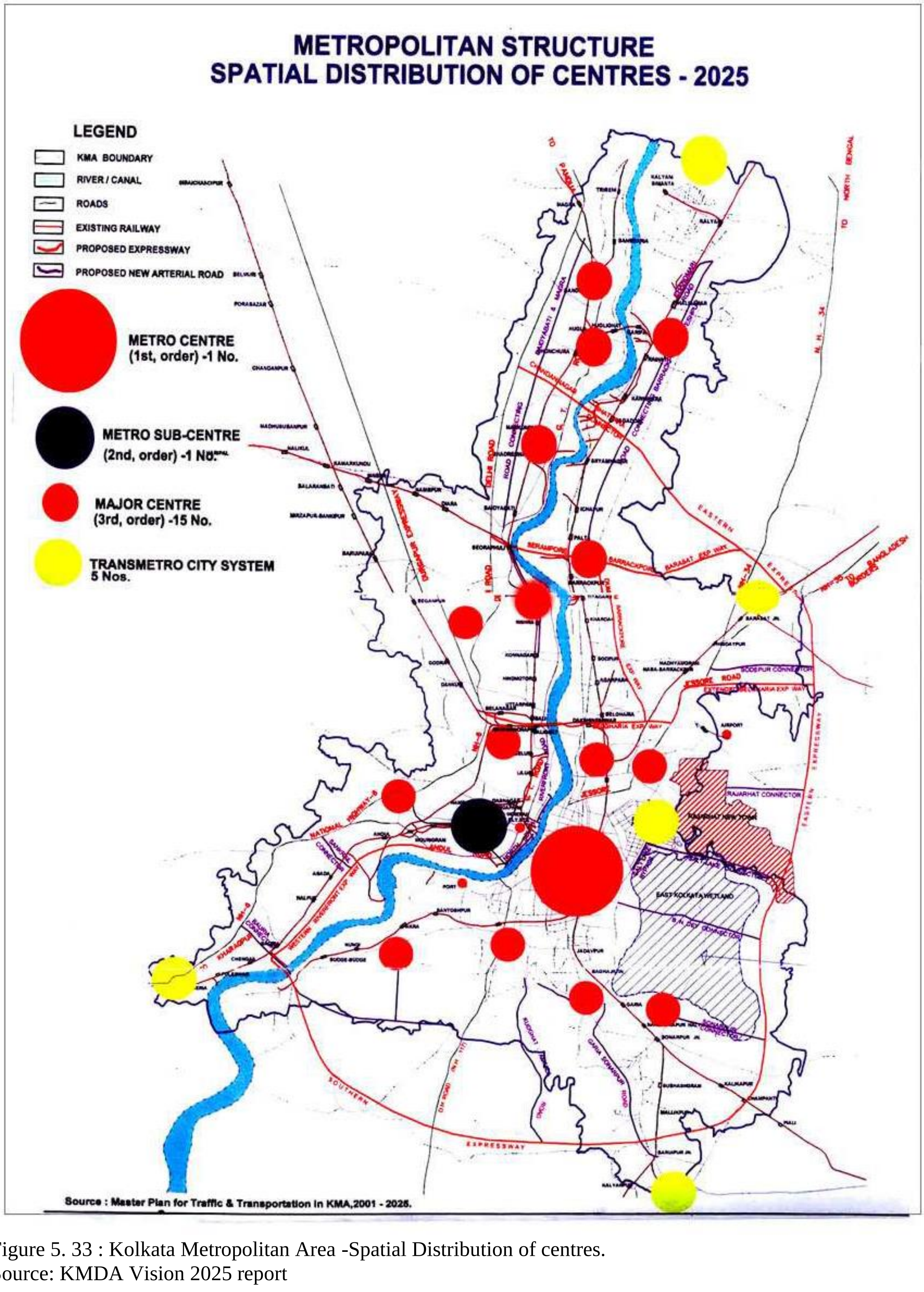


Figure 5. 33 : Kolkata Metropolitan Area -Spatial Distribution of centres.
Source: KMDA Vision 2025 report

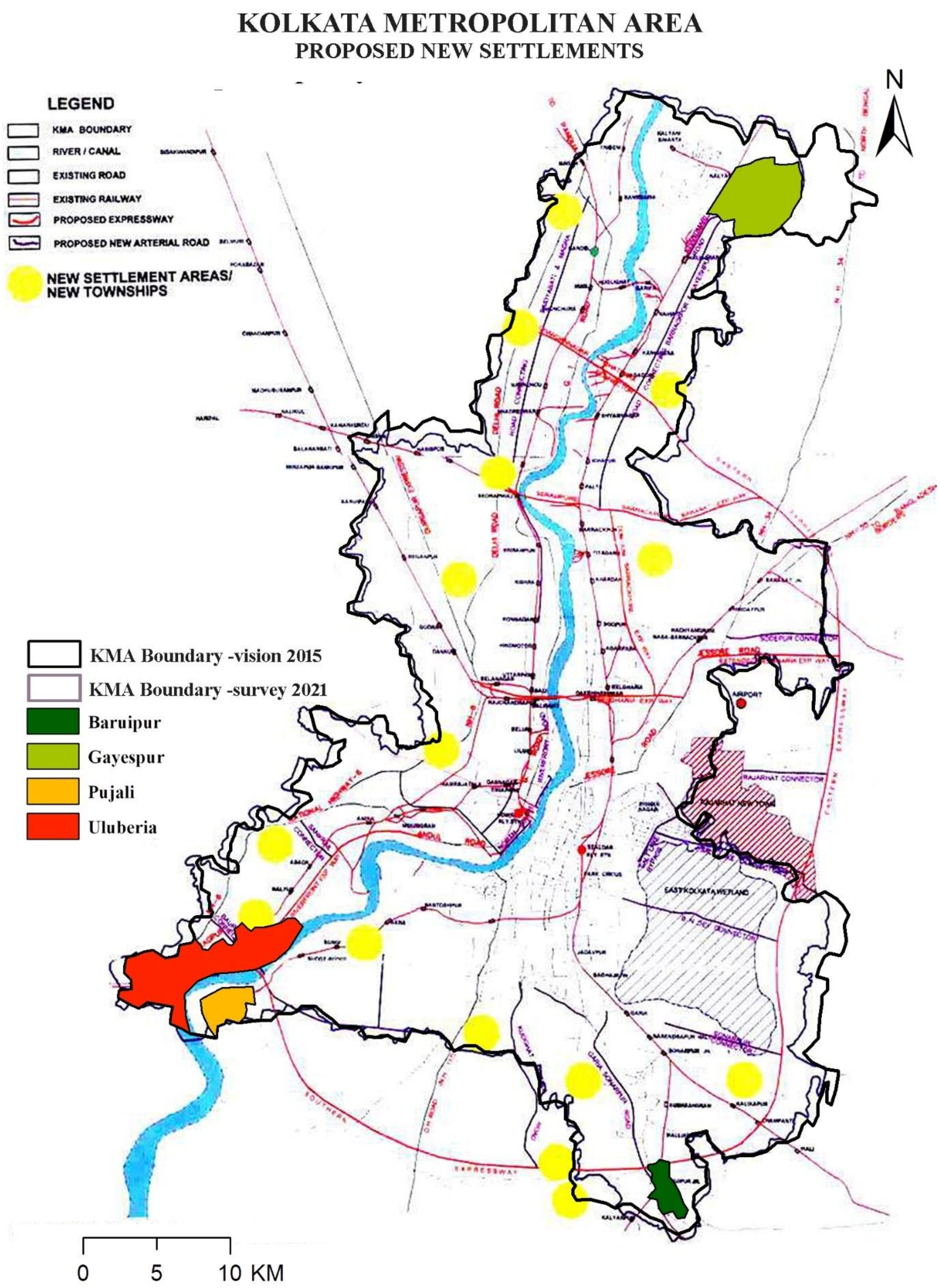


Figure 5. 34 : Kolkata Metropolitan Area -Identified 4 non saturated zones with growth potential superimposed on New settlement proposal by KMDA
Source: KMDA Vision 2025 report

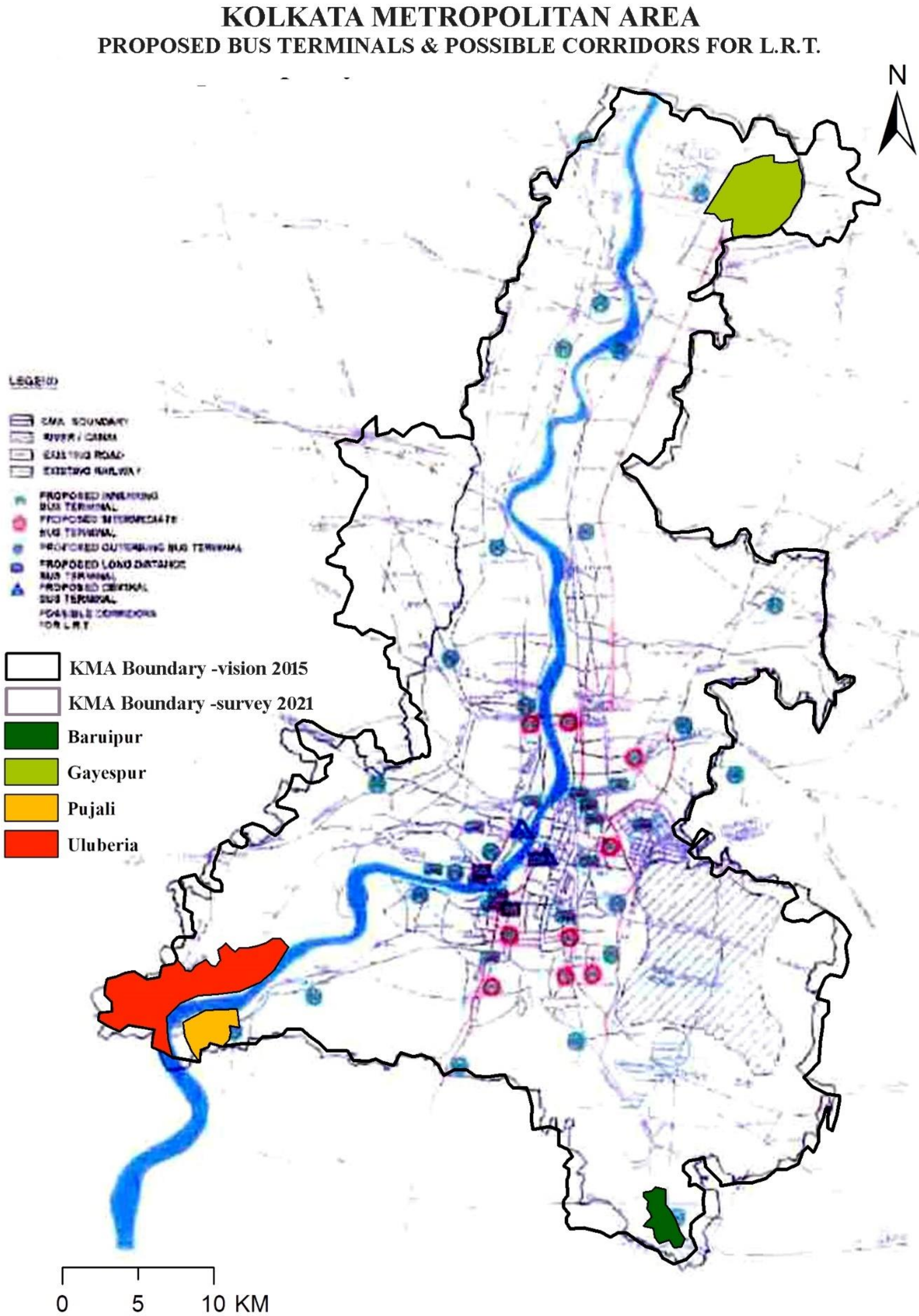


Figure 5. 35 : Kolkata Metropolitan Area -Identified 4 non saturated zones with growth potential superimposed on New Bus Terminal & Transport corridor plan proposal by KMDA
Source: KMDA Vision 2025 report

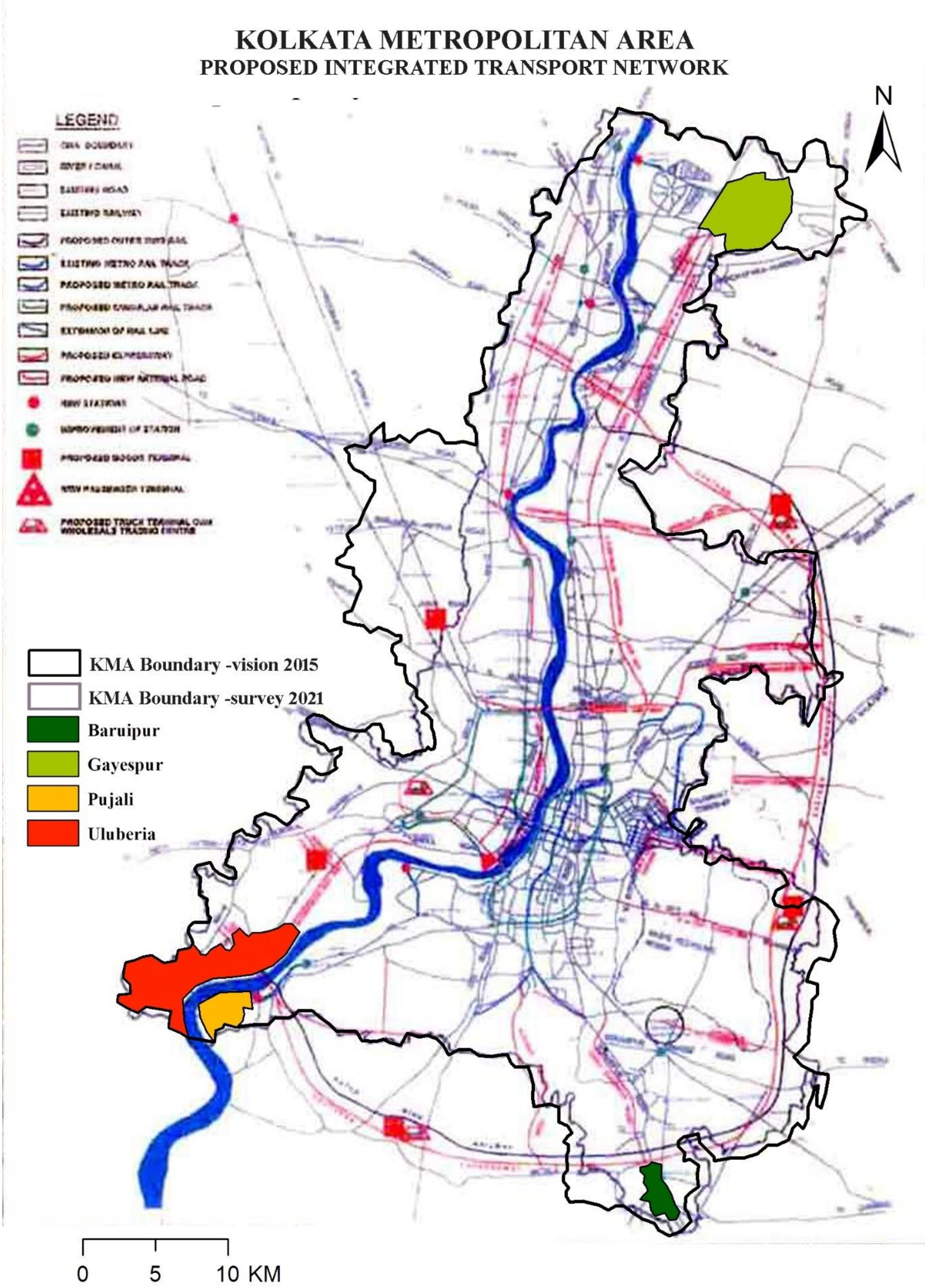


Figure 5. 36 : Kolkata Metropolitan Area -Identified 4 non saturated zones with growth potential superimposed on Integrated transport Network plan proposal by KMDA
Source: KMDA Vision 2025 report

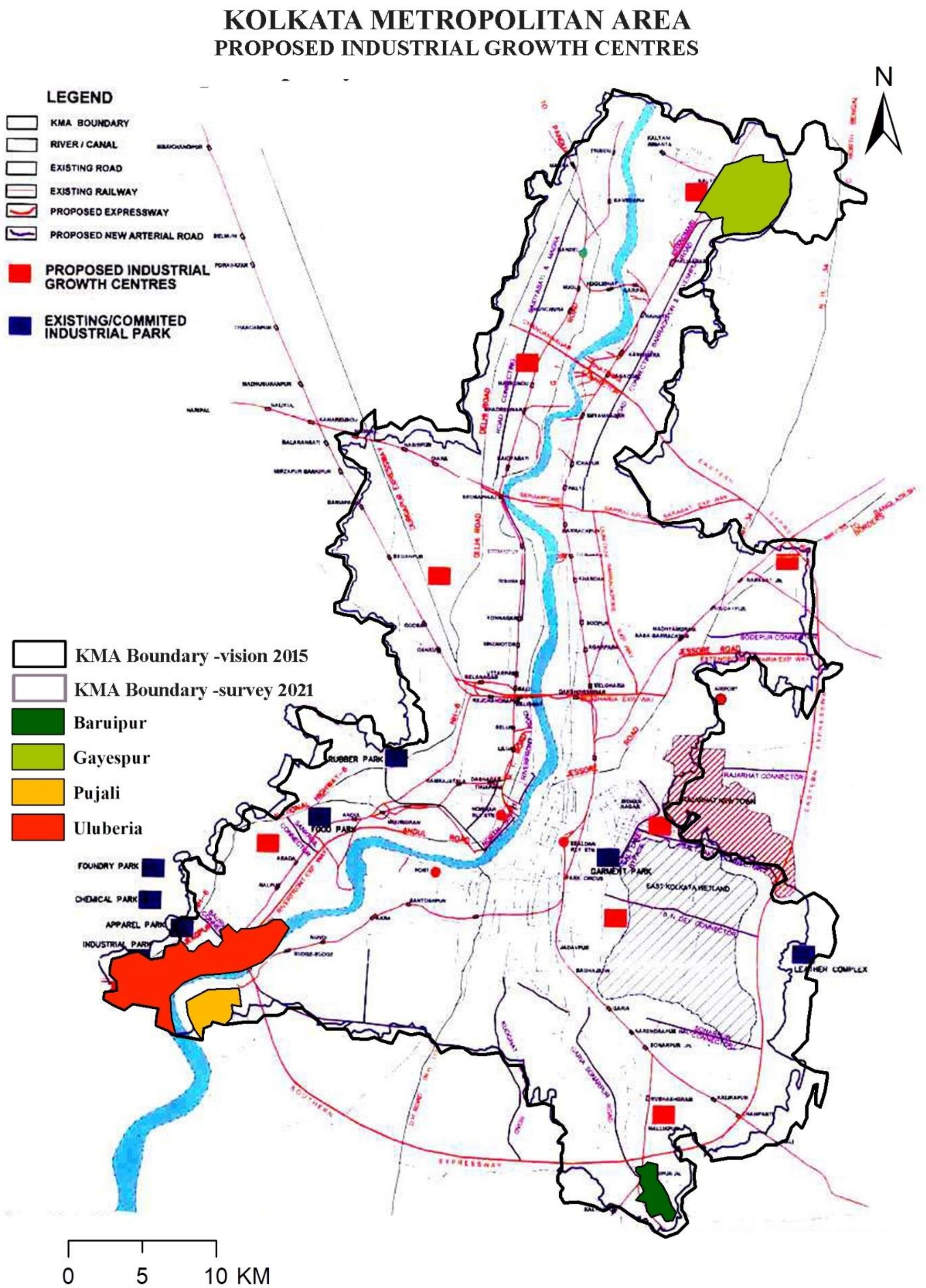


Figure 5. 37 : Kolkata Metropolitan Area -Identified 4 non saturated zones with growth potential superimposed on Proposed Industrial growth centre by KMDA
Source: KMDA Vision 2025 report

In the last updated VISION 2025- by KMDA there was prediction and proposal for new settlements and fig.5.29 shows that the 4 non-saturated areas a) **Baruipur b) Gayespur c) Pujali d) Uluberia proved** to be the new upcoming zones of settlement development after superimposition of current LULC map of KMA on the vision plan. Fig 5.35, Fig 5.36, Fig.5.37 further confirm the potential of the above mentioned four areas in terms of connectivity, and industrial growth centres near them. Proposed outer ring roads will enhance the connectivity from these areas from the city centre and the CBD areas. Hence these four areas stands out in the list to do further research for developing effective guidelines in respect with human settlement pattern generation within.

5.7 Inferences and Conclusion

1. Kolkata Metropolitan area is experiencing and uneven development all over.
2. Many pockets in fringe already saturated/ exhausted having lack of infrastructure
3. Infrastructure and amenities are not adequate in the peri-urban areas.
4. Every un-saturated zone with growth and development potential is still in lack of proper vision document solely meant to cater to their unique characteristics.
5. With rising demand of population, the still available land be again in danger of turning into an urban slum like the existing city core.
6. The pattern of settlement remaining as unstated, unclear, uneven with lack of a effective development control plan providing strict guidelines and a constructive governance.
7. Attention required to improve mass rapid corridors to improve accessibility with fringe
8. Absence of any restriction in Land use change causes rapid engulfing of rural land in and uneffective manner.

This section identified 4 areas as below to be studied further in micro level in the next chapter:

1. **Baruipur, 2. Gayespur, 3. Pujali, 4. Uluberia**

6: Result and Interpretation of Objective 4

Objective IV: To analyse the significance of indicators under growth, governance & globalisation influencing the human settlement pattern in the micro level study areas therefore identifying of drawbacks of the existing scenario.

Density, Literacy, Total female workers, non-agricultural population, decadal growth rate are considered as urbanization indicators while doing composite weightage analysis for these micro level study areas.

The following map refers to the unsaturated zones of West Bengal selected through required analysis as elaborated in the previous chapter.

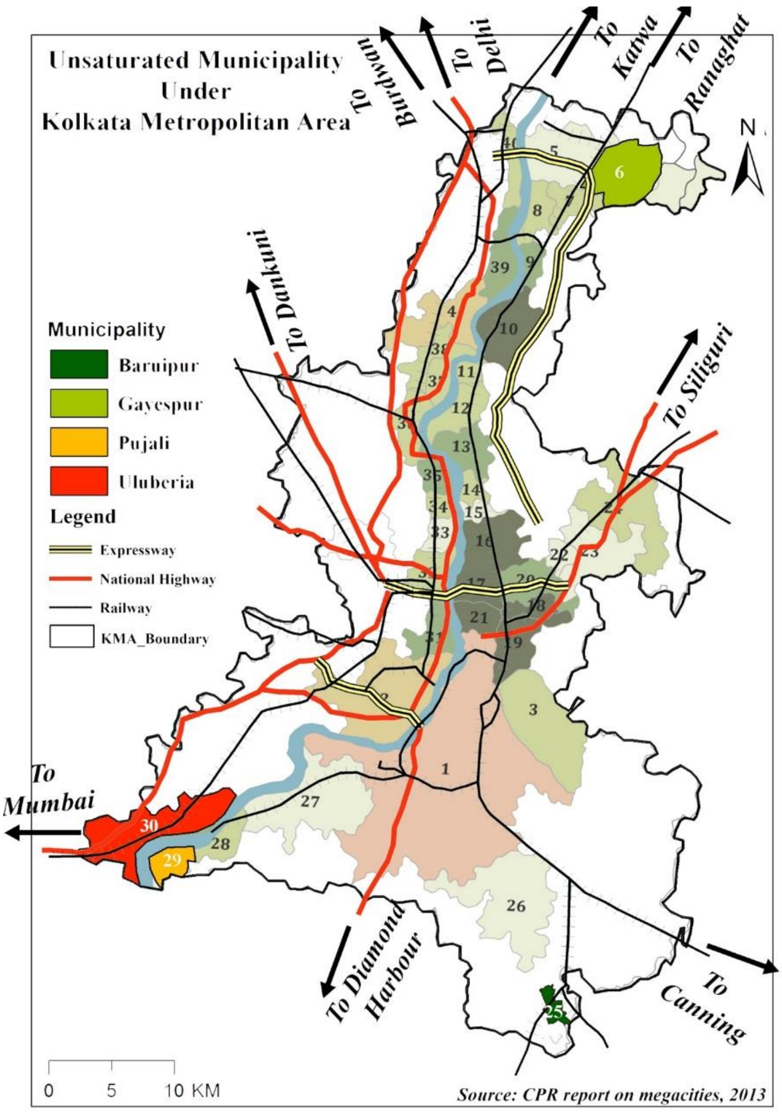


Figure 6. 1 : Location of four pocket shadow zone (Peri-Urban) in KMA area.

Source: Author. Landsat Data Image and GIS Mapping

6.1 Analysing the significance of indicators under growth, governance & globalisation

6.1.1 Delimitation of Baruipur Municipality

The municipality of Baruipur was investigated in depth as an example of a non-saturated area with room for expansion. Baruipur is located 27 kilometers south of Kolkata and is accessible by both road and rail. Baruipur connects all of the key towns and locations in the South 24 Parganas district to Kolkata. The regional road network of Baruipur stretches out in all directions. The Garia – Baruipur Road, popularly known as the Kulpi Road, connects the area to Kolkata and the North 24 Parganas via the E.M Bye Pass. Kolkata's eastern outskirts, including Salt Lake townships and the rapidly rising Rajarhat Township, are connected by the Eastern Metropolitan Bypass. Other significant roads, including as Madarat Road, Dhabdhabi Road, and Canning Road, connect the region to its eastern part, while Amtala Road connects it to its western part. The road is in good shape. The Kheyadaha Road, the Narayanpur–Bodra Road, and the Chakraberia–Baruipur Road are all key routes that connect the area to neighboring places. The town is served by a railway that connects it to the rest of the region. Baruipur Junction, the nearest railway station, connects this municipality to Kolkata and the southern part of South 24 Parganas. The area's suburban rail services serve the region's primary transit movement. It also handles the daily transportation of the majority of vegetables and fruits to Kolkata and other cities. The table below provides a demographic overview of the municipality.

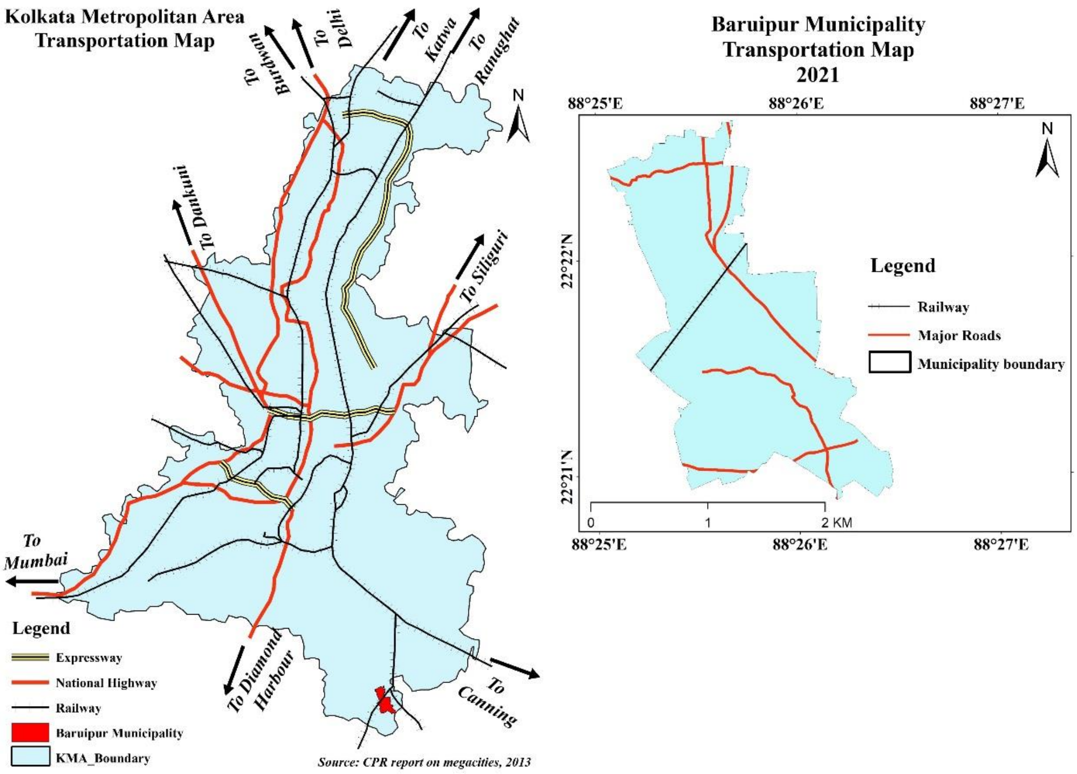


Figure 6. 2 : Baruipur Municipality, the pocket shadow zone (Peri-Urban) in KMA area showing transport network. Source: Author. Landsat Data Image and GIS Mapping

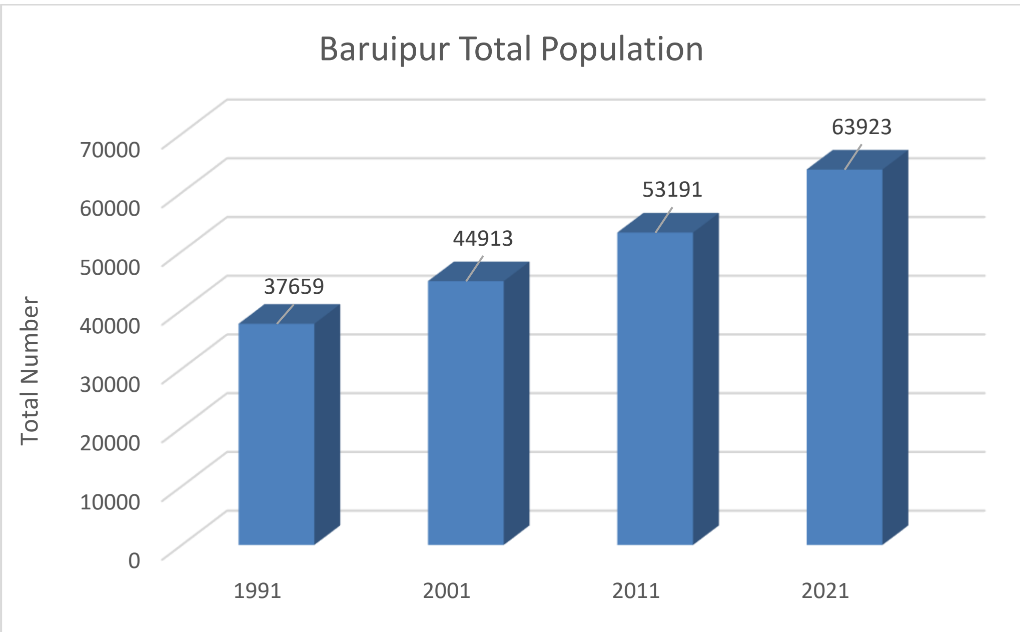


Figure 6. 3 : Baruipur Municipality, the pocket shadow zone (Peri-Urban) in KMA area showing decadal growth. Source: Author. Landsat Data Image and GIS Mapping

Table 6. 1 : Overview of Baruipur Municipality.

1.	**Population**	**2001**	**2011**	**2021(Projected)**
		44,913	53,191	62,923
2.	**Density**	2001	2011	
		7930 persons per sq. Km	9381 persons per sq. Km	
3.	**Decadal growth rate**	19.26%		
4.	**No of Households**	**2001**	**2011**	
		9608	13403	

Source: Census, DDP and Baruipur Municipality

When compared to the total population of West Bengal and the South 24 Parganas district, the population of Baruipur is relatively small. According to the 2011 census, the population of Baruipur is only 0.06 percent of the state and 0.7 percent of the district population. Baruipur with its negligible share of the population in comparison to the population size of South 24 Parganas district is driven by factors such as i) nearly 75 percent of the population of South 24 Parganas seems to be rural, and ii) of the residual 25 percent population, which is urban, municipal authorities such as Maheshtala and Rajpur Sonarpur are predominant, with their accumulated share recording more than 40 percent while Baruipur only accounts for 3 percent of the share of Urban Population. However, in terms of population growth rate, Baruipur has recorded around 19.2 percent growth, which is higher than West Bengal's (13.8 percent) and South 24 Parganas' (18.2 percent) decadal growth rates between 2001 and 2011. Figure 6.3 demonstrates that:

- Decadal population increase was extraordinarily rapid between 1951 and 1991, with the highest rates reported during 1961-71 and 1971-81, respectively, at more than 50%. This is owing to inbound migration from Bangladesh, which shares a border with South 24 Parganas at the time.
- As mentioned in the preceding section, a ward-by-ward population size study clearly demonstrates the municipality's growth direction. Figure 12 illustrates that the municipality's northernmost wards (1,2,12, and 13) are substantially more populated (average population size is approximately 3500) than the municipality's southern wards (6,7,8,9, and 16), which have an average population size of around 3000. Ward 10 is the most populous ward in the municipality, and it is located in the municipality's central section.

- Similarly, when the population growth rate (2001-2011) is assessed, the municipality's northernmost wards show a 35 percent growth rate compared to a 12 percent growth rate in the southern zone. The overall geographical area of the municipality in relation to the total geographical area of the South 24 Parganas district is less than 1% of the total geographical area due to the district's rural nature. The population density in 2013 was 9381 persons per square kilometer, which is considered to be low.

As it is enclosed by a number of villages and its structure is elongated around 4.3 km from north to south, the formation of settlement pattern of Baruipur is strongly influenced by its location, shape, transportation route, and surrounding rural population. Kolkata is located in the municipality's northern outskirts. The city is expanding rapidly, particularly to the north. It is for this reason that most areas of Northern Municipality have seen expansion, primarily in the real estate sector. As a result of this, the development of the municipality's southern part has been uneven. In terms of ward-wise building plans sanctioned by the municipality during the 2007-12 period, analysis shows that the maximum number of building plans were sanctioned in wards 4 and 10, followed by wards 1,6,12, and 14 with more than 150 building plans sanctioned in each ward. Wards such as 3, 7, 9, 15, and 17, on the other hand, have had a low number of building plans approved in the last five years (less than 60 no. during 2007-12). Table 6.2 shows the most promising wards in terms of growth as measured by the municipality, as well as the underlying reason for the growth in these wards.

Table 6. 2 : Growth Patterns & drivers in Baruipur Municipality. Source: Field Survey by Author

Area/ Ward	Nature of Growth			Growth Drivers			
	Residential	Commercial	Industry	Pressure from adjacent village	Proximity to Employment	Infrastructure	Vacant Land availability
1	√	√			√	√	√
2	√	√			√	√	√
4	√			√			√
5	√			√			√
6	√	√		√		√	√
10	√	√			√	√	√
12	√	√			√	√	√
16	√			√		√	√

From the above table, following key points are coming out:

- Wards 1, 2, and 16, the city's three northernmost wards, have experienced significant growth, owing primarily to their proximity to Kolkata and the availability of vacant land.
- Four wards (4,5,6, and 10) in the city's central zone have grown in recent years, owing primarily to the availability of vacant land and, to a lesser extent, to inward migration from adjacent rural areas, which has resulted in residential growth.

In contrast to the preceding, the area's growth dynamics in terms of upcoming real estate projects are significantly more apparent towards the fringes of the municipality. A number of private developers are constructing huge residential projects due to the amount of vacant land available in the municipality's neighbouring community Mouzas. Examples include the Vibgyor Group, Sharda Group, and others.

According to the GIS Platform, the total area of Baruipur is 567 Ha or 5.67 square kilometres. The various utilities and detailed features of Baruipur Land use were mapped in GIS and broadly classified in accordance with UDPFI guidelines.

Table 6. 3 : Land use distribution of Baruipur. Source: Census, DDP and Baruipur Municipality

	Land Categories	Area in Sq. Km	% of the Total area		Land Categories	Area in Sq. Km	% of the Total area
1.	**Residential**	**3.09**	**54.4%**	6.	**Agriculture**	**0.38**	**6.7%**
2.	**Commercial**	**0.04**	**0.7%**	7.	**Plantation**	**0.76**	**13.5%**
3.	**Institutional**	**0.06**	**1.1%**	8.	**Water body**	**0.46**	**8.0%**
4.	**Transport area**	**0.59**	**10.4%**	9.	**Vacant land**	**0.22**	**3.9%**
5.	**Recreational**	**0.07**	**1.2%**				
	Total Area	5.674 Area in Sq.Km.					

The existing land use/land cover map of Baruipur town was created using high resolution WorldView-2 satellite images. The information was analysed and visualised using GIS software. Ground-truthing and field surveys were used to validate the data derived from satellite images. The municipality's area is 9.07 square kilometres, according to census, DDP, and other publicly available reports. However, after completing GIS slum boundary validation and municipality boundary demarcation, the municipality's area has been estimated to be around 5.67 square kilometres. As a result, in this report, the total area is 5.67 square kilometres, which is our estimate, rather than 9.07 square kilometres.

Because Baruipur is primarily a residential area with few industrial activities, the industrial and commercial zones have been combined. Baruipur is home to 25 educational institutions and 16 health care facilities. All of these have been categorised as Institutional. Baruipur's land use pattern is heavily influenced by the main road and rail route, as well as its proximity to Kolkata. As a result, the main residential, commercial, and public-semi-public areas are concentrated along the transportation route, with a focus on the north. Agricultural and plantation areas are mostly concentrated on the southern outskirts. The image below depicts the land use characteristics of the shadow zone of Baruipur.

According to a household survey, four out of every hundred households in the district of South 24 Parganas do not have a place to sleep at night, and another half of the households live in a house/hut with only one room. 45 percent of households in Baruipur live in pucca or partially pucca houses. Housing in its slums is in poor condition, with 80 percent of houses being Katcha or semi-pucca. Considering the foregoing, the municipality has already begun piecemeal construction of affordable houses in 40 slums spread across 17 wards, leveraging the BSUP scheme in a phased manner. During the first phase (2008-2012), 543 houses were built in 29 slums spread across 12 wards. Infrastructure projects such as road, drainage, and pipeline construction were also prioritised in some of the slums. 1102 dwelling units were built in the second phase (2009-ongoing) until 2012, along with a CC Road, a shallow drain, and a water supply distribution line.

Baruipur Municipality has a water supply deficit that is expected to grow to 7.69 MLD in 2016. The population does not have access to water in the areas served by piped water supply because water supply is intermittent throughout the town and only available for 6 hours a day, and water in some slum pockets contained arsenic. Taking into account the aforementioned gap, the Baruipur Municipality has initiated a water supply project under JNNURM to improve the situation in all 17 wards of the Municipality. The project, which is being carried out by the Kolkata Metropolitan Water Supply and Sanitation Authority, entails the construction of I one semi-underground reservoir with a capacity of 0.25 million gallons, ii) clear water pumps, and iii) a booster chlorination plant, among other things. There is no household level drainage facility in slums, resulting in an unsanitary environment. A number of interventions are required to improve sanitation and sewerage facilities. The Municipality of Baruipur's solid waste management is not in accordance with the MSW (Management and Handling) Rules 2000. Garbage is collected from door to door by tricycle vans from all wards and temporarily stored in Municipality-managed vat points (primary collection centres). There is also a lack of timely collection and disposal to the existing dumping ground in Ward 8, resulting in dumping in drains and the spread of foul odours in the primary disposal point. Baruipur's road network has expanded to 123 kilometres. While more than 60% of roads are black-topped and concrete, approximately 16% of the road network is still kachcha road, and 23% is brick road. The majority of existing arterial roads are narrow, with two-lane carriageways, and must be widened to accommodate increased vehicular traffic. The surface conditions of the roads are poor due to a lack of proper maintenance, which reduces the speed of moving traffic. Several initiatives and infrastructure development projects, such as KUSP, BSUP, SSHUP, and JNNURM, have been undertaken in recent years.

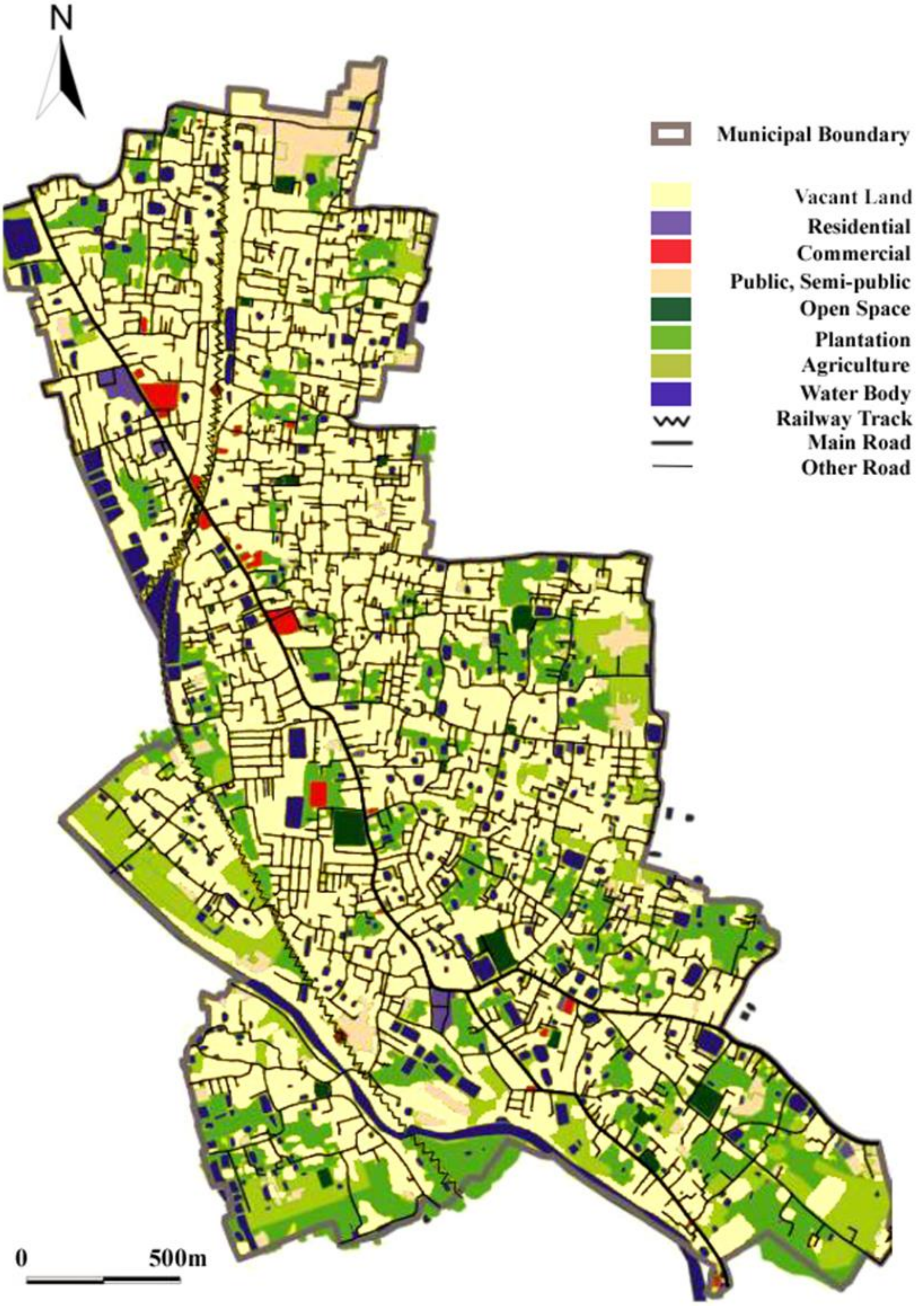


Figure 6. 4 : Baruipur Municipality, the pocket shadow zone (Peri-Urban) in KMA area Detail Land Use Mapping. Source: Author. Landsat Data Image and GIS Mapping

6.1.2 Delimitation of Gayespur Municipality

Gayespur Municipality was studied in depth as an example of a non-saturated area with potential growth. Gayespur municipality is located in the northern fringe of the Kolkata Metropolitan District and is at about 72 kilometers north of Kolkata.

It is approached via two state highways. The eastern approach is via National Highway 34, while the western approach is via Delhi Road. Gayespur is also connected by suburban railways, with two railway stations nearby. Kalyani Railway Station is located on its outskirts in the north-west, and Kanchrapara Railway Station is located in the west. NH34 connects all of the important towns and places in West Bengal's northern districts to Kolkata via Gayespur. Gayespur is also well connected by road to the Barrackpore Kalyani Expressway (which leads to Kolkata) via Kulia Kachrapara on one side and the NH2 & Durgapur Expressway on the other side of the Ganga via Vidyasagar Setu. The Kalyani-Barrackpore Expressway runs very close to Gayespur Municipality's southern boundary. Mooraganchha Road, which runs along the Municipality's northern border, connects rail and road. These two roads are of high quality and provide the municipal area with improved access to and from various origins and destinations. They serve as the driving force behind Gayespur's rapid development. Netaji Subhash Road, the municipal area's spine, and some of its arterial roads connect the major inhabited locations. Gayespur Municipality has a comprehensive road network with a total length of 201.6 kilometres. The nearest station is Kalyani Railway Station, which is 2.6 kilometres from Gayespur and 50-55 kilometres from Sealdah and Howrah railway stations. The train service from Kolkata to Kalyani railway station is extremely frequent. Suburban rail services in this area via Kalyani station contribute to the area's major transit movement. It also transports the majority of vegetables and fruits to Kolkata and other cities on a daily basis. The nearest airport is Netaji Subhash Chandra Bose Airport in Kolkata, which is 48 kilometres from Gayespur.

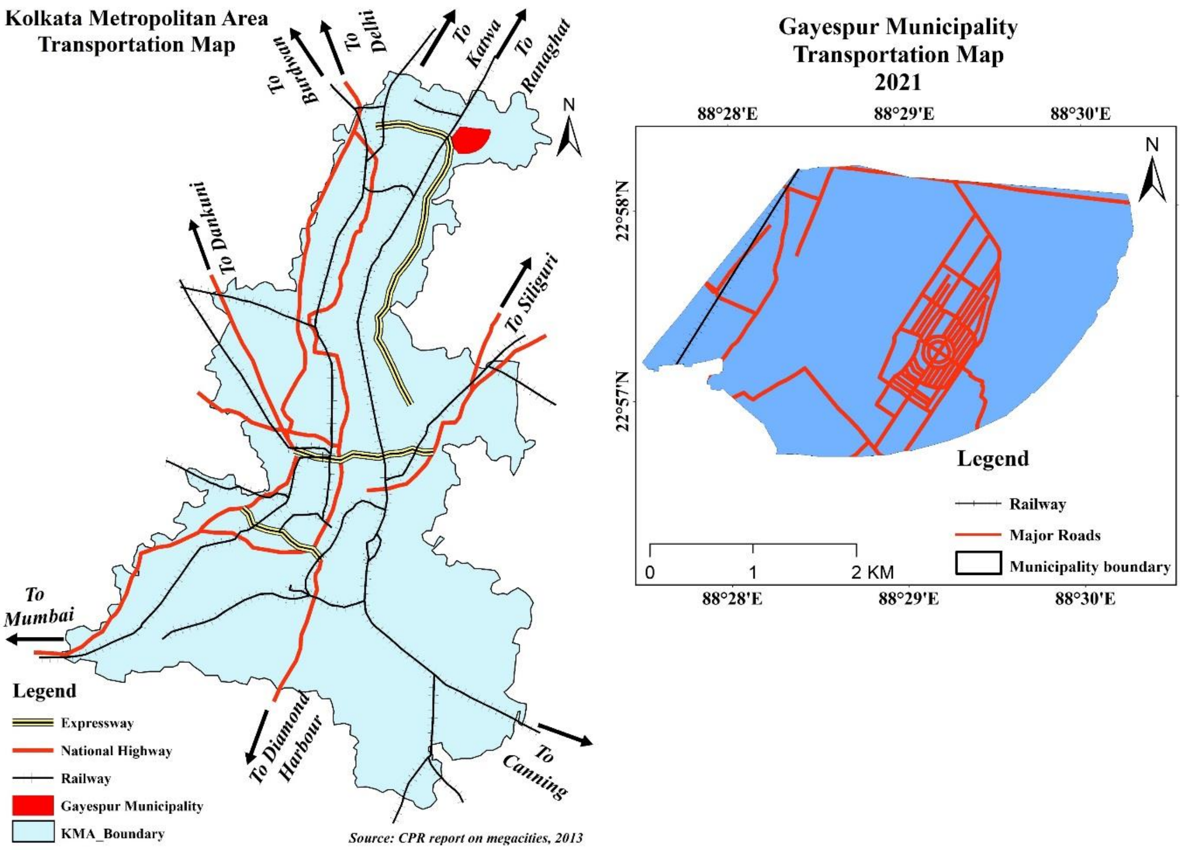


Figure 6. 5 : Gayespur Municipality, the pocket shadow zone (Peri-Urban) in KMA area showing transport network . Source: Author. Landsat Data Image and GIS Mapping

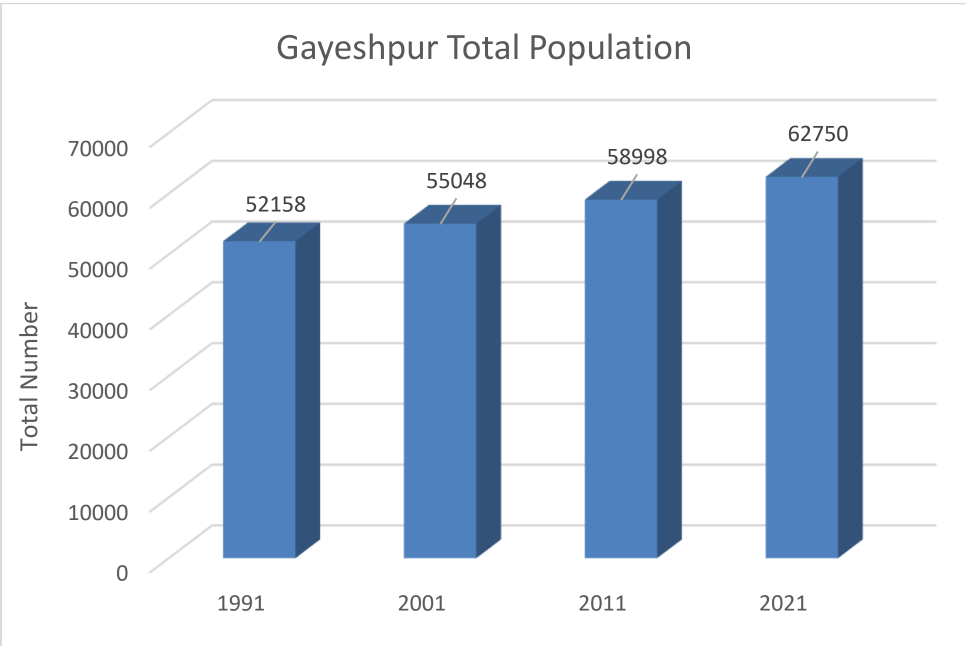


Figure 6. 6 : Decadal growth in Gayespur Municipality
Source: Author. Landsat Data Image and GIS Mapping

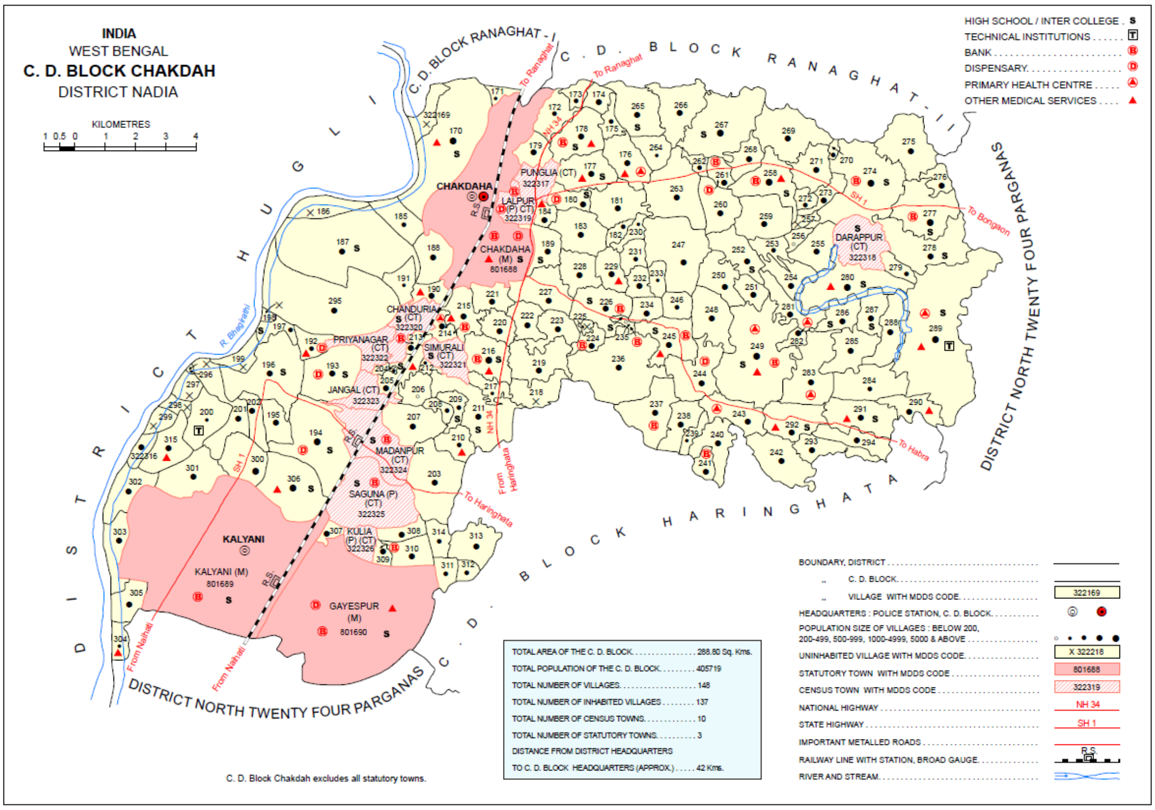


Figure 6. 7 : Overview of Gayspur Municipality

Gayespur was designated as a notified area on September 1, 1979. Prior to this, the area was practically without administrative jurisdiction or coverage, and it was associated with the Saguna Gram Panchayat, which had a dubious track record. Following India's independence, a colony was established in this forestland with the financial assistance of the West Bengal Government's Refugee Rehabilitation Department.

Table 6. 4 : Redistribution of population, Nadia, 2001-2011. Source: Census, DDP and Baruipur Municipality

Name of C.D. Blocks/ Municipality/	Population	%	Population	%	Difference
NA	**2011**	**2011**	**2001**	**2001**	**In (%) 2011-2001**
Gayeshpur M	58998	1.14	55048	1.2	**-0.06**

Gayespur Notified Area was elevated to the level of Municipality-Status in 1995. Gayespur Municipality has a spatial extent of about 30 square kilometres and a population of 58,998 people, according to the 2011 Census of India. Gayespur municipality is bounded to the north-west by Kalyani Municipality and to the south by Mathura Beel. The northern boundary of the Saguna Gram Panchayat area is the river Hooghly, while the southwestern boundary is partially delimited by the river Hooghly and the rest by the Kanchrapara Municipal Administrative Boundary. The number of children aged 0 to 6 in Gayespur is 4491, accounting for 7.61 percent of the total population (M). The Female Sex Ratio in Gayespur Municipality is 979, compared to the state average of 950. Furthermore, the Child Sex Ratio in Gayespur is around 986, which is higher than the West Bengal state average of 956. Gayespur's literacy rate is 90.49 percent higher than the state average of 76.26 percent. Male literacy in Gayespur is around 94.19 percent, while female literacy is around 86.71 percent.

Table 6. 5 : Growth Patterns & drivers in Gayespur Municipality. Source: Field Survey by Author

Area/ Ward	Nature of Growth			Growth Drivers			
	Residential	Commercial	Industrial	Pressure from adjacent village	Proximity to Employment	Infrastructure	Vacant land availability
3	√					√	
8			√		√		
9	√	√		√	√	√	
10	√	√				√	
11	√						
13		√	√			√	
14	√						
15	√	√			√	√	
17			√		√		
18	√	√		√		√	

Gayeshpur is located next to Kalyani, which is the district's educational and medical centre. Gayeshpur municipality has a population of 55,048 people and a land area of 30 sq. km. Men make up 51 percent of the population. Gayeshpur has an overall literacy rate of 81 percent, with 85 percent of men and 76 percent of women being literate. Children under the age of six make up 8% of the total population. Despite the fact that India has a diverse ethnic population, the Kalyani–Gayeshpur region is ethnically homogeneous. According to the 2011 Census, 35.4 percent of the population in this region is from the scheduled castes, and 2.7 percent is from the scheduled tribes. The majority of the population speaks Bengali; common tribal communities include the Mundas and Oraons. This is a stable population with almost no immigration and little emigration, ensuring little loss to follow up on. Gayeshpur's existing water supply is primarily derived from ground water, which is pumped from 16 large pumping stations located throughout the municipality. Gayeshpur's municipal areas are telescopically linked with higher capacity and coherent drains to the nearest points of the Nayanjuli Canal and Beel system. In Gayeshpur Municipal Area, all 18 wards have been covered with an intensive drainage network to keep waste water and flooding at bay. Garbage is collected door to door by tricycle vans from all wards and temporarily stored in vat points managed by the municipality (primary collection centres). The majority of existing arterial roads are blacktop and narrow, with two-lane carriageways, and need to be widened to accommodate increased vehicular traffic. The road surface conditions are poor due to a lack of proper maintenance, which slows moving traffic. Gayespur, as a well-connected municipal area and the gateway to the adjacent planned city Kalyani, has now grown into an educational and medical hub as well. Regional Research Station (RRS), New Alluvial Zone (NAZ), BCKV, Gayeshpur is one of six Regional Research Stations established in anticipation of the ICAR's NARP implementation in 1990. The State Government deeded many farms or stations to BCKV for the purpose of conducting research on agricultural development and allied activities while keeping in mind the zonal requirements of the respective region. Gayespur is home to the National Institute of Bio-Medical Genomics and the 350-bed Gandhi Memorial Hospital. The recently established IISER Kolkata and AIIMS Kalyani are located near Gayespur. The development of a strong transportation corridor and the establishment of educational and health-care institutes have created a great potential for this area in terms of job creation and self-sufficiency. The massive lockdown in the Kalyani-Gayespur industrial sector over the last 25 years has resulted in a large number of people losing their jobs and being forced to switch to other small-scale businesses or services.

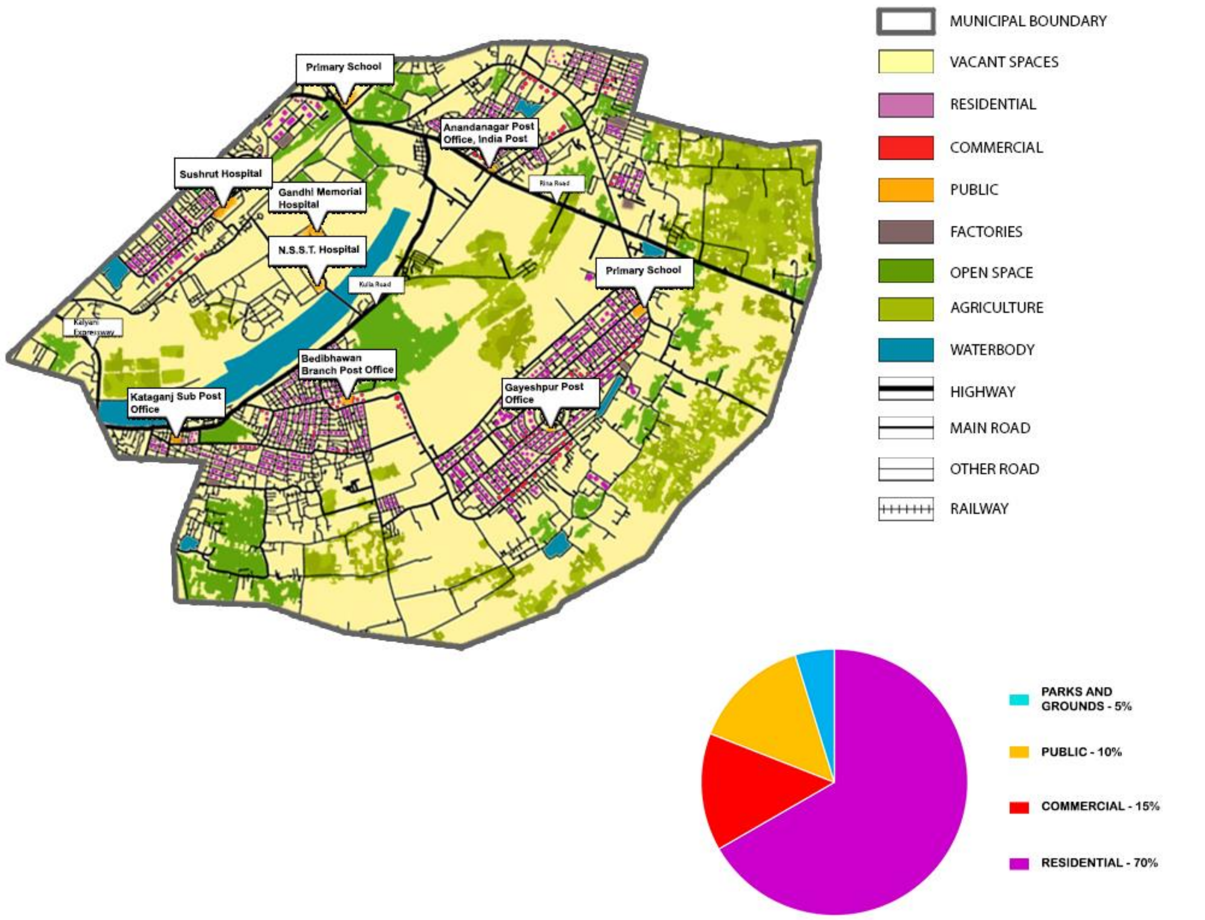


Figure 6. 8 : Gayespur Municipality, the pocket shadow zone (Peri-Urban) in KMA area Detail Land Use Mapping. Source: Author. Landsat Data Image and GIS Mapping

6.1.3 Delimitation of Pujali Municipality

Pujali municipality is one of the smallest municipalities on the eastern bank of the Hooghly River (located at 22.47°N 88.15°E with an average elevation of 6 metres) in the Kolkata Metropolitan Area. It falls under the jurisdiction of the Budge Budge Police Station, which is located in the Alipore Sadar Sub-division of the South 24 Parganas District of West Bengal. The Pujali municipality has seen rapid land transformation and development. Pujali has been expanding its horizons ever since the CESC established a massive Thermal Power Station in 1993. According to Census 2011, the total population of the municipality was 37,047, with a decadal growth rate of 9.42 percent from 2001 to 2011, divided into 15 wards. The municipality's total area is 8.32 square kilometres. The West Bengal Municipal Act 1993 (u/s 297 amended in 1998) governs all types of planning in this municipality, which was planned by the municipality's authorities with the participation of local residents.

The municipality was formed by combining the entire Pujali Gram Panchayat and a portion of the Rajibpur municipality, both of which were part of the Budge Budge subdivision in Twenty-four Parganas (South). Pujali was a non-municipal town within Pujali gramme panchayat, and Kalipur was an outgrowth of the Budge Budge municipality. There was an alternate history in the area. It is the site of the first Chinese settlement before they moved to the inner cores of Kolkata. The location was also the first in India to have a sugar factory, which was established over 500 years ago. This area, located on the Hooghly River's bank, was more of a ring road to the Budge Budge than it was Kolkata. The area drew attention when the Calcutta Electric Supply Corporation (CESC) announced plans to build a thermal power plant in the Budge Budge area to address the daily power shortage in the core city. The Calcutta Metropolitan Development Authority (CMDA, later renamed the KMDA) began acquiring land for the purpose. Pujali is still the thermal power town after nearly two decades. Many people did not see municipalisation as a result of the thermal power plant's construction. In fact, in many areas, thermal power plants did not necessarily result in municipalisation or urbanisation. Pujali is currently being developed as a river-side day tourist destination as a result of municipalisation.

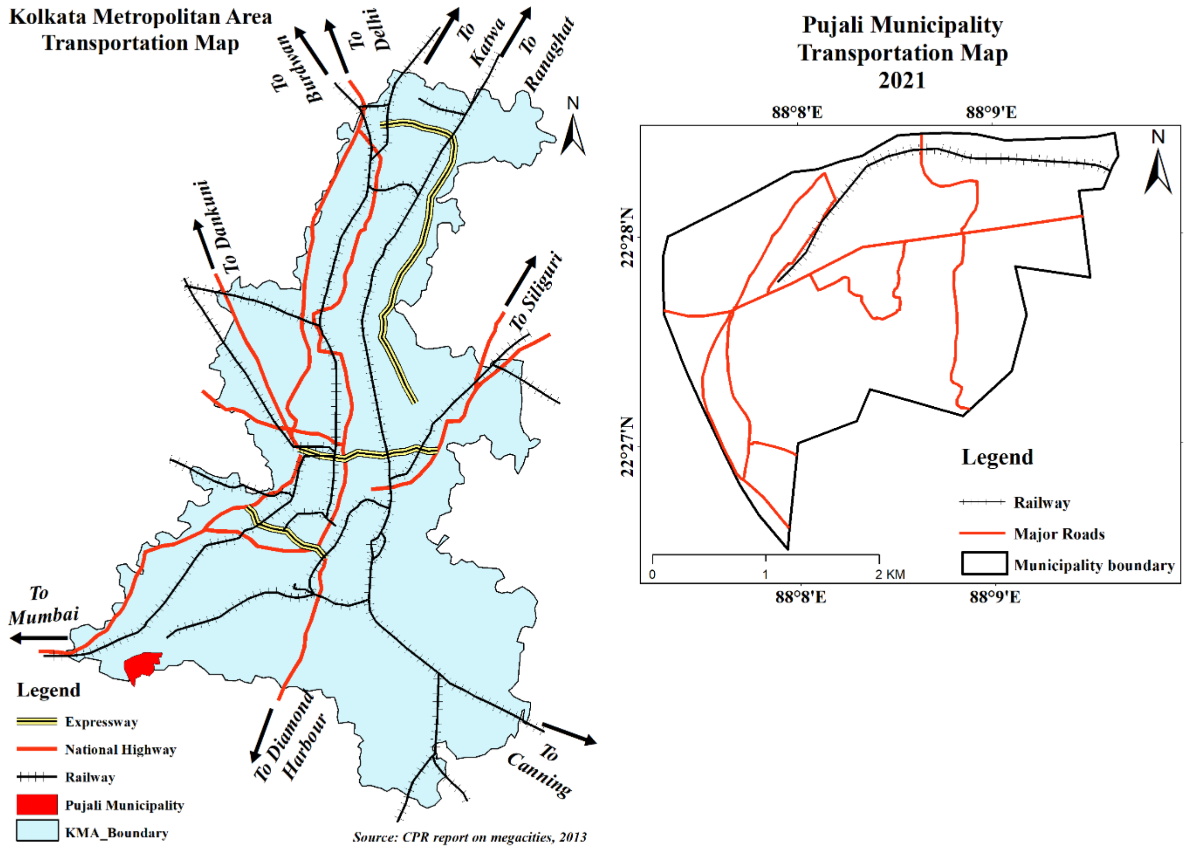


Figure 6. 9 : Pujali Municipality, the pocket shadow zone (Peri-Urban) in KMA area showing transport network. Source: Author. Landsat Data Image and GIS Mapping

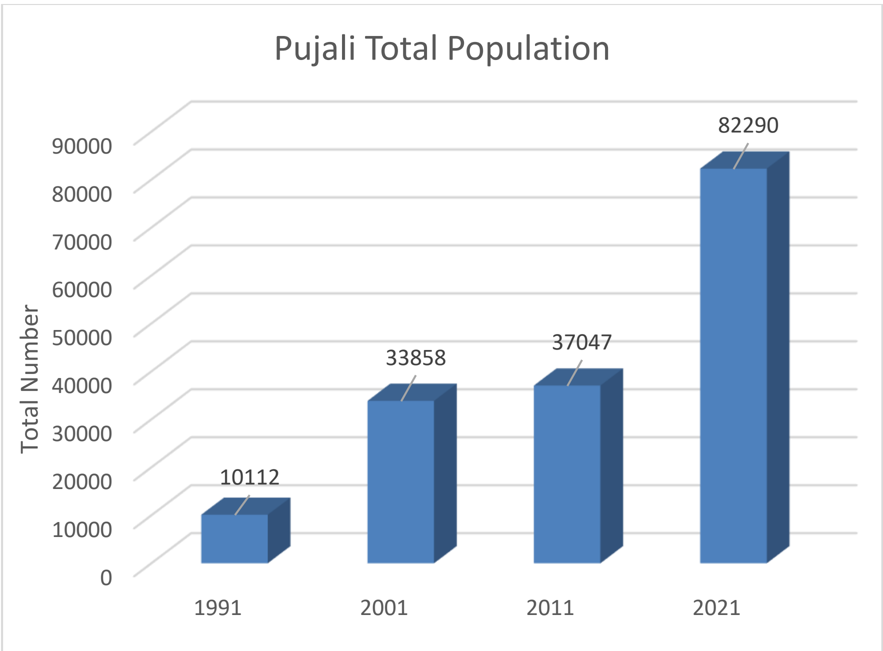


Figure 6. 10 : Pujali Municipality, the pocket shadow zone (Peri-Urban) in KMA area showing decadal growth Source: Author. Landsat Data Image and GIS Mapping

Table 6. 6 : Growth Patterns & drivers in Pujali Municipality. Source: Field Survey by Author

Area / Ward	Nature of Growth			Growth Drivers			
	Residential	Commercial	Industrial	Pressure from adjacent village	Proximity to Employment	Infrastructure	Vacant land availability
3			√		√	√	√
4			√		√		√
6	√	√				√	
7	√	√				√	√
9	√			√			
10	√	√				√	
13	√						
14	√				√	√	
15	√	√				√	

The northern portion of the municipality has a high density in 2001 due to its easy accessibility via ferry services from Pujali to the Chengail area. Because of its proximity to Kolkata, the eastern portion of the municipality has experienced relatively high population density over the years. However, the population density in the western part of this municipality is high due to infrastructural facilities such as a bank, a post office, a school, and, in particular, ferry services between Pujali and Uluberia. In recent years, population concentration has been high on both the eastern and western sides of the municipality area. The eastern side has a high population concentration due to easy access via the Budge Budge Trunk road and ferry services between Chengail and Pujali. However, due to the availability of ferry services between Pujali and Uluberia, the population concentration on the western side is high. The availability of vacant land has resulted in a high rate of population and household growth in Wards 3, 4, 6, 7, 10, and 13. It encourages people from other areas to relocate to these areas. This municipality's chances of future growth are extremely slim. This is because it is bounded on the west and north by the Hooghly River, on the east by the Budge Budge I Community Development Block and the Budge Budge Municipality, and on the south by the Bishnupur Community Development Block.

Salient Features of Influence Zone between 2001 and 2011:

Pujali Municipality's sphere of influence has shrunk by 0.43 km between 2001 and 2011. One of the primary reasons for this is that the Gram Panchayats of South 24 Parganas, namely Joka I and Joka II, were added to the Kolkata Municipal Corporation after September of 2012. KMC has a greater impact than Pujali Municipality. Because the majority of the residents of this municipality used to commute to Kolkata for work. In Kolkata, they work in the private sector, such as hotels and restaurants. Another reason is that in recent years, most of the rural areas in the KMA that fall under the jurisdiction of the South 24 Parganas have been converted into Census Towns. As a result, between 2001 and 2011, the urban areas in South 24 Parganas increased by nearly 51.19 km, and the number of Census Towns in South 24 Parganas under the jurisdiction of KMA increased from 5 to 27. These Census Towns have a much greater influence over the residents of the Pujali Municipality.

Public works is the sector where the town has spent the most money in recent years. The average expenditure in all three sectors, however, has decreased. This could be due to a greater reliance on the KMDA and the state for the provision of these services. For example, in terms of water supply, these three towns are primarily reliant on KMW&SA and, to a lesser extent, Garden Reach water works from KMC. Roads have been one of the most important sectors where municipalisation has played a role in bringing about change in Pujali.

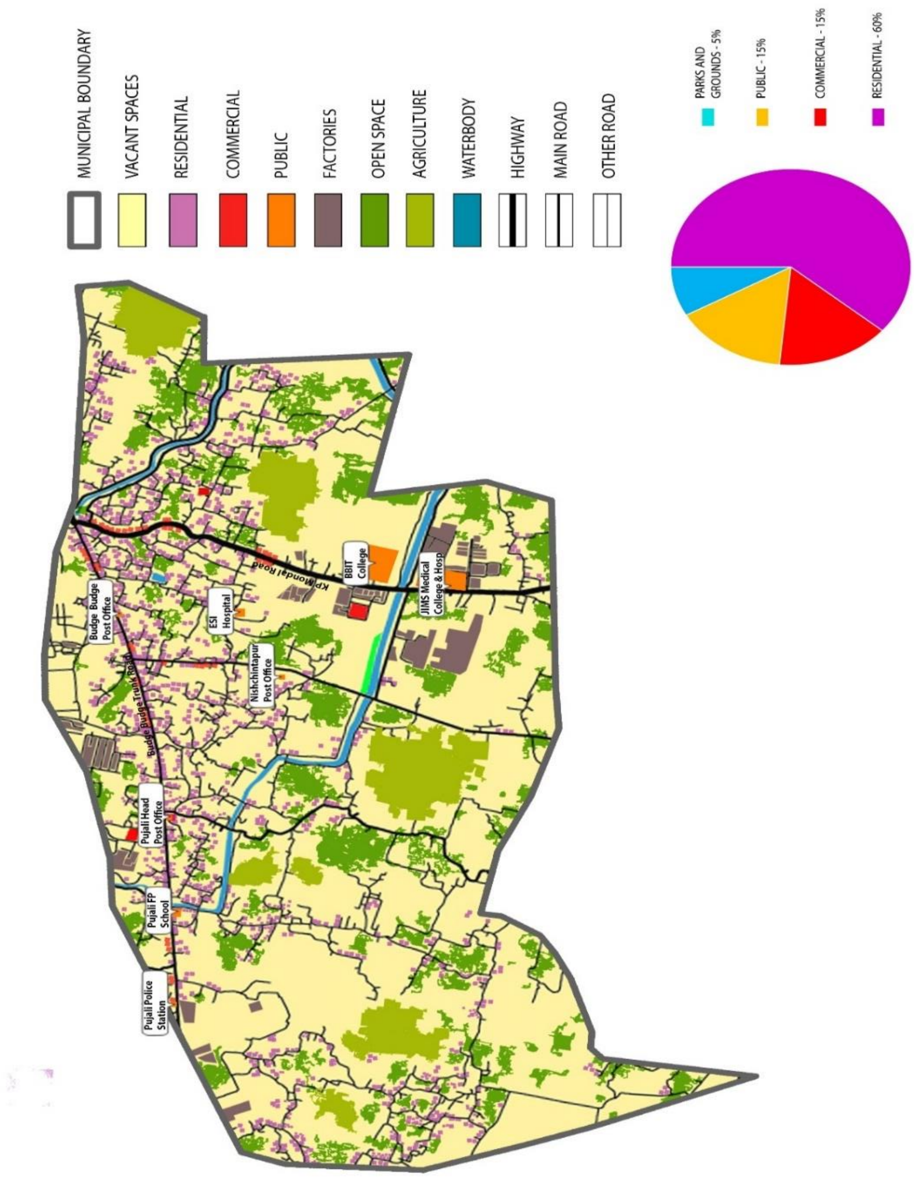


Figure 6. 11 : Pujali Municipality, the pocket shadow zone (Peri-Urban) in KMA area Detail Land Use Mapping. Source: Author. Landsat Data Image and GIS Mapping

6.1.4 Delimitation of Uluberia Municipality

The municipality of Uluberia was thoroughly investigated as an example of a non-saturated area with potential growth. Uluberia municipality is located on the south-western outskirts of Kolkata Metropolitan District, approximately 40 kilometres from Kolkata and 27 kilometres from Howrah. Uluberia Municipal Corporation is part of the Kolkata Metropolitan Development

Authority (KMDA) and is located near the Howrah Municipal Corporation. The municipality is situated on the left bank of the Hooghly River. Since 1982, it is the head-quarter of Uluberia subdivision and Uluberia C.D. block. The total geographical area of the Uluberia municipality is 33.72 square kilometres with a population of 230,000inh.in 2011 (District census handbook, 2011). National Highway-6, railway lines (South-Eastern Railway) and state highway go through the municipality. All of the important towns and places in western districts like Medinipur of West Bengal are linked to Kolkata via Uluberia by NH6; Bombay Road & to Howrah via NH16. These two roads are of high quality and provide the municipal area with improved access to and from various origins and destinations. They serve as the driving force behind Uluberia's rapid development. The rail service from Howrah to Uluberia railway station is extremely frequent. Suburban rail services in this area via Uluberia station contribute to the area's major transit movement. It also transports the majority of vegetables and fruits to Kolkata and other cities on a daily basis.

The rate of population growth is a multi-factor function influenced by fertility, mortality, and migration. In the case of Uluberia municipality, migration is the most important factor influencing population growth. With India's partition in 1947 came a large number of East Pakistani refugees, who mostly settled in Kolkata and its surrounding areas, forming colonies on the banks of the Hooghly River, including near Uluberia on the west bank. Population growth in the Uluberia municipality and its surrounding areas follows the Ravenstein distance decay law (Ravenstein, 1889); (Tobler, 1995), which states that population growth decreases with increasing distance.

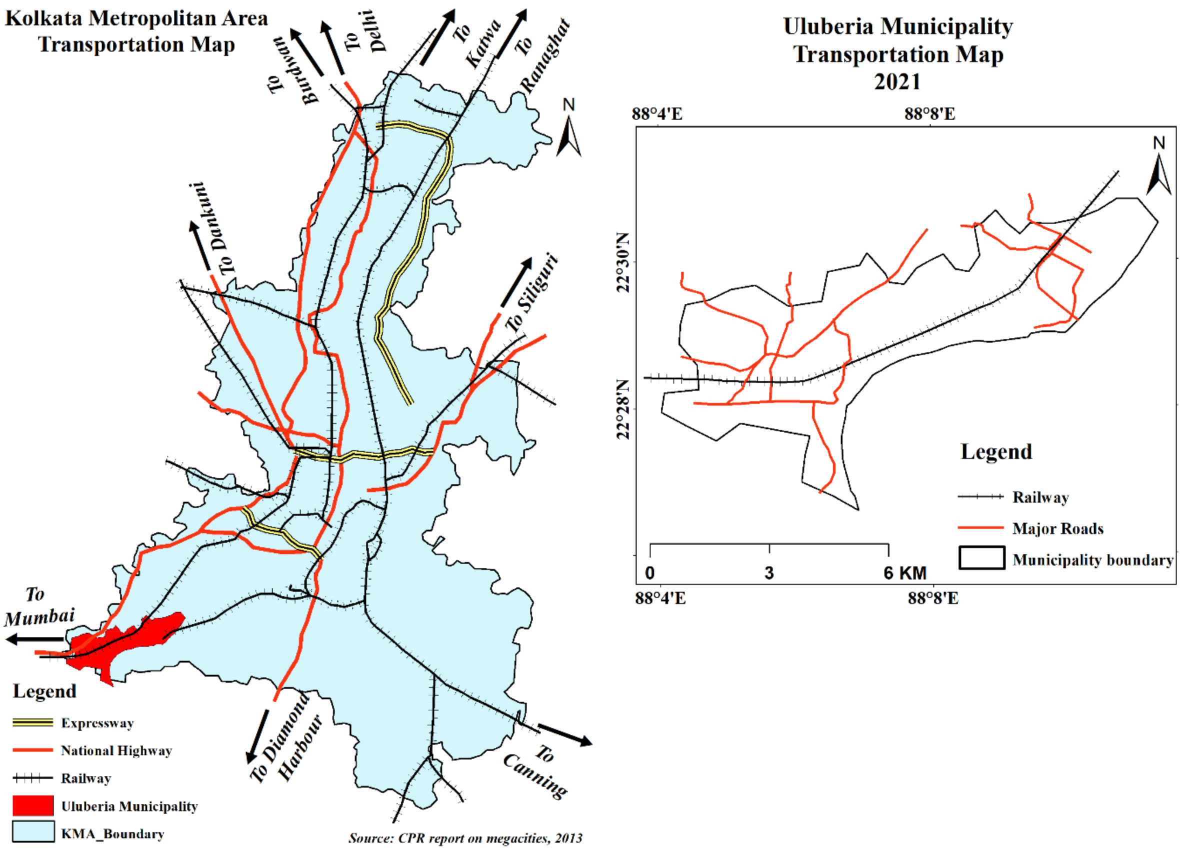


Figure 6. 12 : Uluberia Municipality, the pocket shadow zone (Peri-Urban) in KMA area showing transport network. Source: Author. Landsat Data Image and GIS Mapping

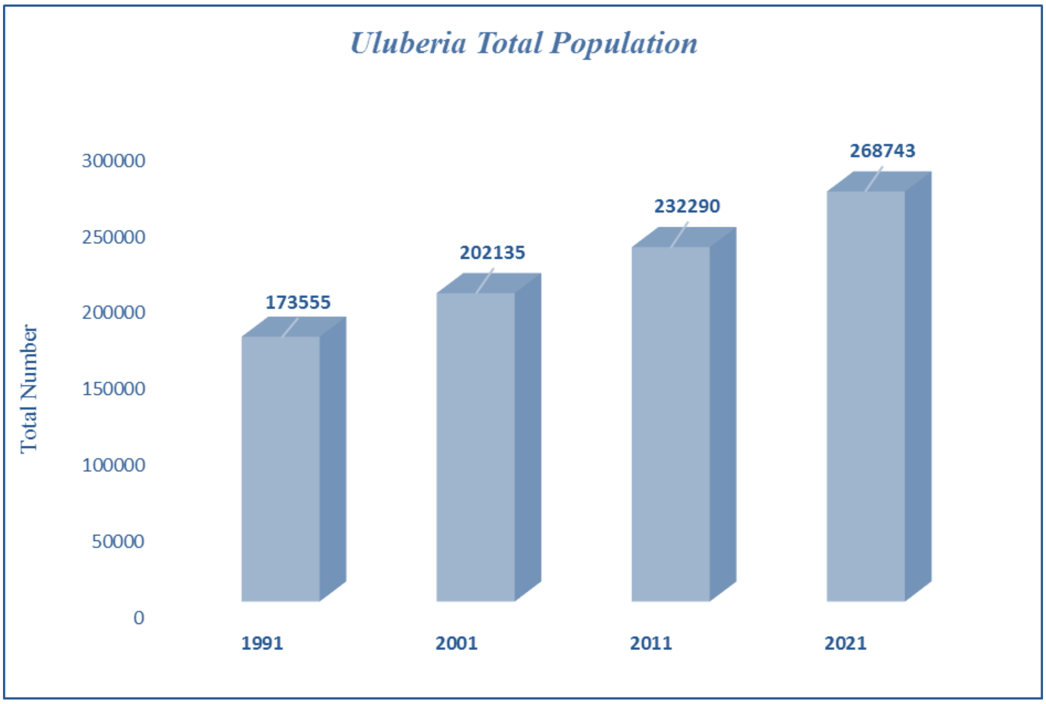


Figure 6. 13 : Uluberia Municipality, the pocket shadow zone (Peri-Urban) in KMA area showing decadal growth Source: Author. Landsat Data Image and GIS Mapping

The population growth rate is clearly unevenly distributed; three villages within the suburb region have a growth rate of more than 56.32 percent and a UI of 26.27 percent (Table 2). From 2001 to 2011, the north, west, and south-west parts of the fringe zone experienced the highest population growth rates (UI, 18.49 to 26.27). (Fig. 4). Aside from migration, illiteracy, poverty, and traditional beliefs are important determinants of higher natural population growth. Because of the lowest population growth, -13.57 to 21.37 percent. the north-eastern part of the fringe belt has been designated as rural fringe.

Household density

A household is a basic unit of a settlement in which people are linked by a co-residential relationship regardless of kinship ties. Because of the high concentration of households, the majority of villages and census towns in the north-eastern part fall within the suburbs and urban fringe. Rural fringe (mean to mean –1 SD) and urban shadow (below mean –1 SD) are extended to the north-west and south-west edges of the municipality where household density is less than 615. The built-up area has grown in a relatively small area in the western part of the fringe area. Households are extended parallel to the railway and national highway in this zone. As a result, a few census towns (Kendua, Osmanpur, Basudebpur, and Brindahanpur) and villages (Gudar, Kasipur, Gauripur, and Kajiakhali) have household densities ranging from 616 to 961 per square kilometre.

Gender ratio

The gender ratio is an important aspect of geographical research because it has a significant impact on other demographic criteria such as population growth, marriage age, migration rate, occupational structure, and so on. The massive influx of male migrants into the periphery creates a gender structure disparity. Villages and census towns with low gender ratios (less than 920) are found in the northern, western, and south-western parts of the RUF, which are referred to as suburb fringe and urban fringe. In the northwestern part of the fringe, which included both the rural fringe and the urban shadow category, the female population outnumbered the male population.

Literacy rate

Literacy is a significant predictor of both social well-being and human development. According to this study, the literacy rate decreases from the suburb fringe to the rural fringe, and the majority of villages and census towns in the suburb fringe and urban fringe are located on the RUF's periphery. Because of lower literacy rates, villages are considered to be part of the rural fringe and urban shadow from the north to the west of the fringe (less than 67.77 percent).

Determinants of economic structure and economic services

Villages closer to the city change their rural character more than those further away. The greater proportion of non-agricultural workers in comparison to total workers is an important feature of the fringe population. The increase in non-agricultural workers is a notable changing phenomenon in the rural-urban nexus.

The municipality of Uluberia provides a wide range of employment opportunities to its rural outlying areas. Surplus labour, low-wage workers, and unemployed residents of the surrounding villages migrate to the city centre in search of these diverse opportunities. Workers were involved in a variety of secondary and tertiary economic activities such as the household and manufacturing industries, construction, trade and commerce, storage, communications, and other services. Because of its proximity to the Howrah-Hugli industrial zone, Kolkata metropolis, and easy accessibility of transportation for various purposes, rural-non-agricultural workers are concentrated in the north-eastern fringe zone. Because of its higher rurality, the northern and southern parts of the rural-urban fringe are in the urban shadow and rural fringe zone. Almost 45 percent of the people in these zones, which are located far from the city centre, work on various primary activities such as agriculture and fishing.

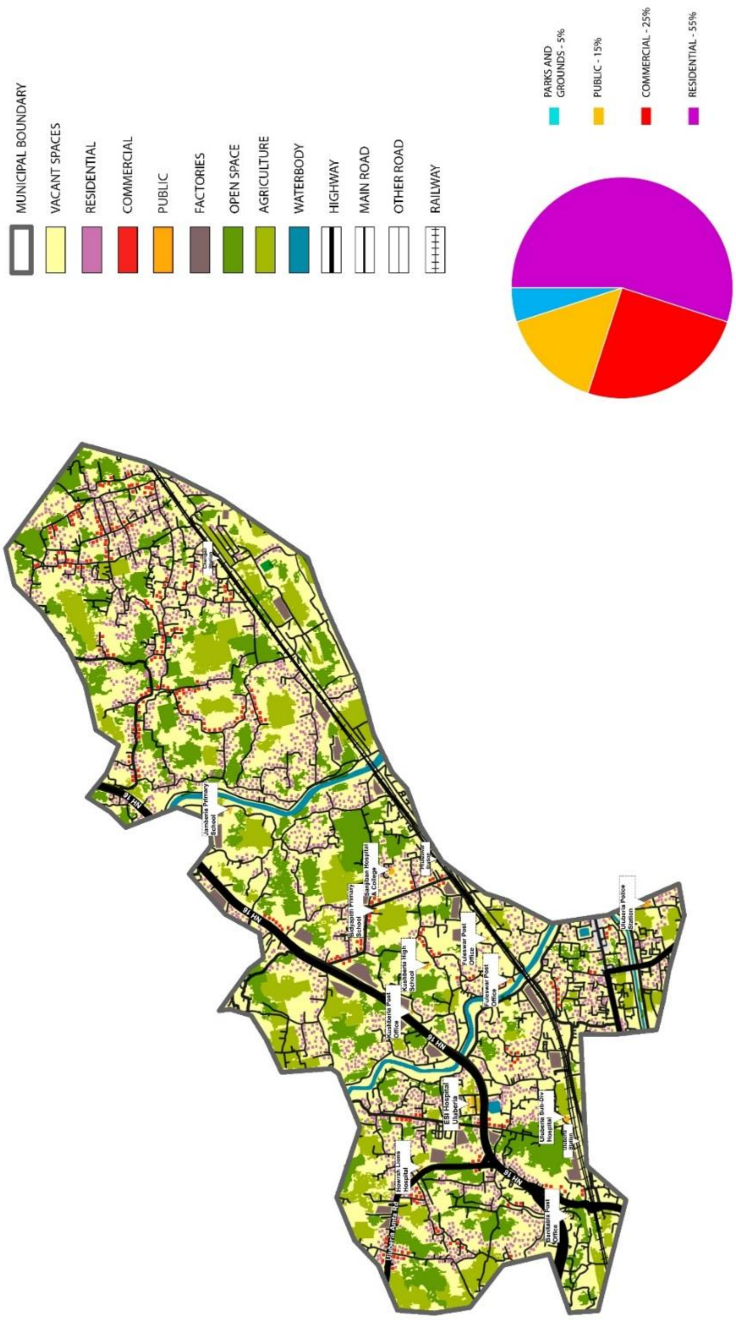


Figure 6. 14 : Uluberia Municipality, the pocket shadow zone (Peri-Urban) in KMA area Detail Land Use Mapping. Source: Author. Landsat Data Image and GIS Mapping

6.1.5 Urbanistic study by LULC mapping

LULC Discussion:

A micro-analysis research was conducted to analyse the time series urbanization in a better way. Hence, from the built-up class, the saturated areas and unsaturated areas were identified based on the percent growth of built up pixels. Bally, South-Dumdum, Rishra, and North Dumdum were recognized as saturated municipality zones, while Baruipur, Gayespur, Pujali, and Uluberia were designated as unsaturated municipality zones. The research was conducted with the development prospects for the four identified unsaturated zones which necessitated the Lulc forecasting for the next 30 years.

In the year 1991, it was observed that the Gayespur zone had a great extent of agricultural land class, especially in the central region. Vegetation cover and fallow lands were primarily observed in the central-eastern region while built-ups were mostly seen in the eastern zone. Waterbodies were predominantly observed in the western region while few clustered pixels were also found in the western region. This scenario has experienced significant changes in the entire 30 years' time spanning from 1991 to 2021. Based upon the fluctuations in the pixels of the Lulc classes, the built up area has dramatically changed in the predicted outcome while almost diminishing the fallow lands. Scattered agricultural land clusters are visible throughout the municipal zone followed by water bodies and vegetation cover.

Baruipur zone had a greater vegetation coverage than the rest of the unsaturated municipal areas in 1991 that has reduced to a great extent and was mainly identified in the southern region however scattered vegetation pixels were noticed throughout the municipal area. The agricultural lands were seen mainly in the central and eastern region of Baruipur at the initial year. The agricultural land class is largely detected in the central portion of the anticipated map, while large clusters of the class pixels were observed across the research area. Fallow lands which were identified especially in the central and south-western region in 1991 and 2001, has reduced steadily and in 2051 no such class pixels could be proclaimed. The built-up class, on the other hand, has been progressively rising from the eastern region until 2021. The projected map demonstrates a significant increase in urbanization, which nearly encompasses the whole study area.

On the other side, the maximum ground extends of Pujali municipality was identified with agricultural land having vegetation especially in the east and west region. The builtups were found to be located in the north and north-west region in 1991, later which was found to have mushroomed in the whole study area. The forecasted map for the next 30 years shows that urban expansion will be concentrated in the northern, eastern, and western zones, while vegetation and agriculture will be spread in the southern and south-central regions.

Steady urban growth was discovered while studying Uluberia that has sprawled from the southern region. The landuse/ landcover maps of this municipality has revealed that this area is dominated by agricultural land followed by vegetation cover in 1991 and 2001. However, the expected outcome for the next 30 years shows that most of the study region will be occupied by extensive urbanisation. Agricultural land will be found mostly in the northern, central, eastern and western sectors of this municipality.

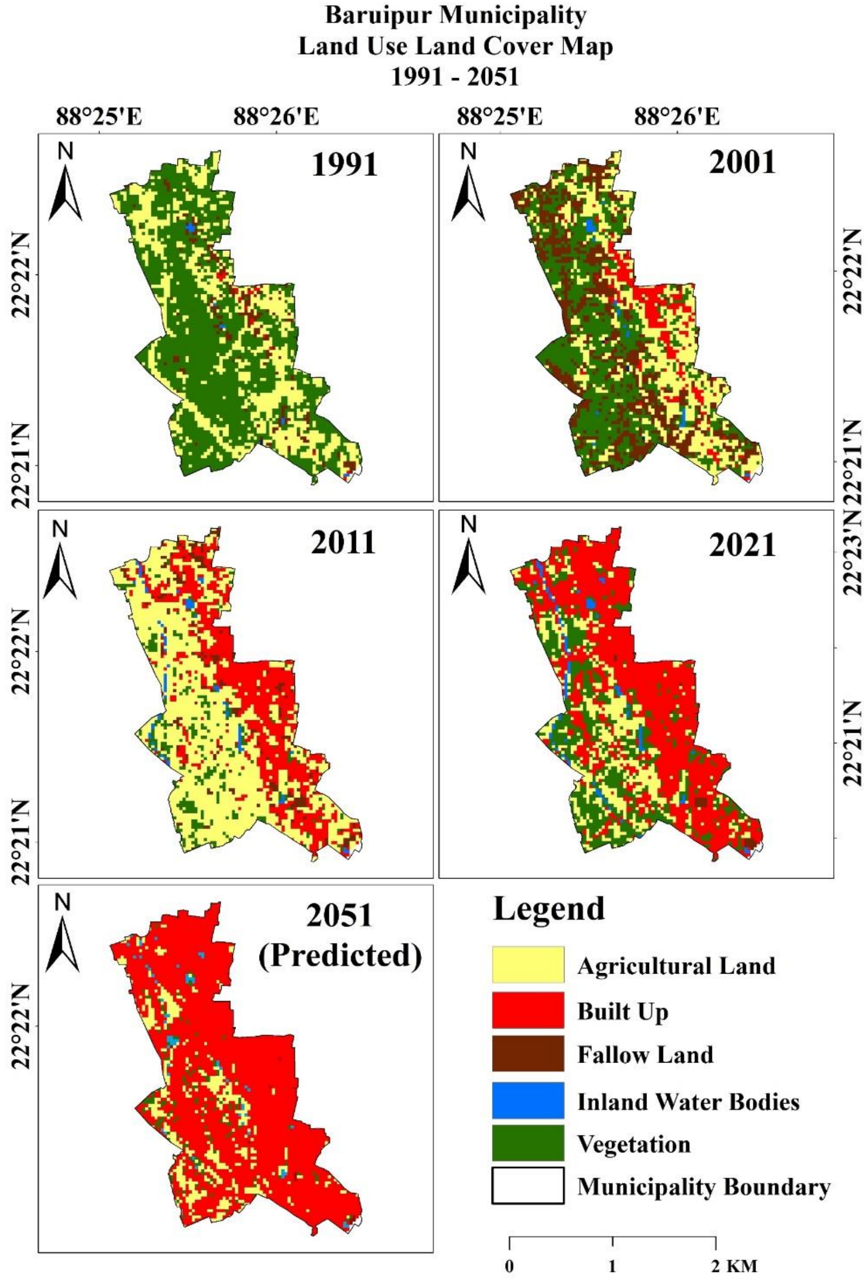


Figure 6. 15: Baruipur Municipality, the pocket shadow zone (Peri-Urban) in KMA area LULC Mapping. Source: Author. Landsat Data Image and GIS Mapping

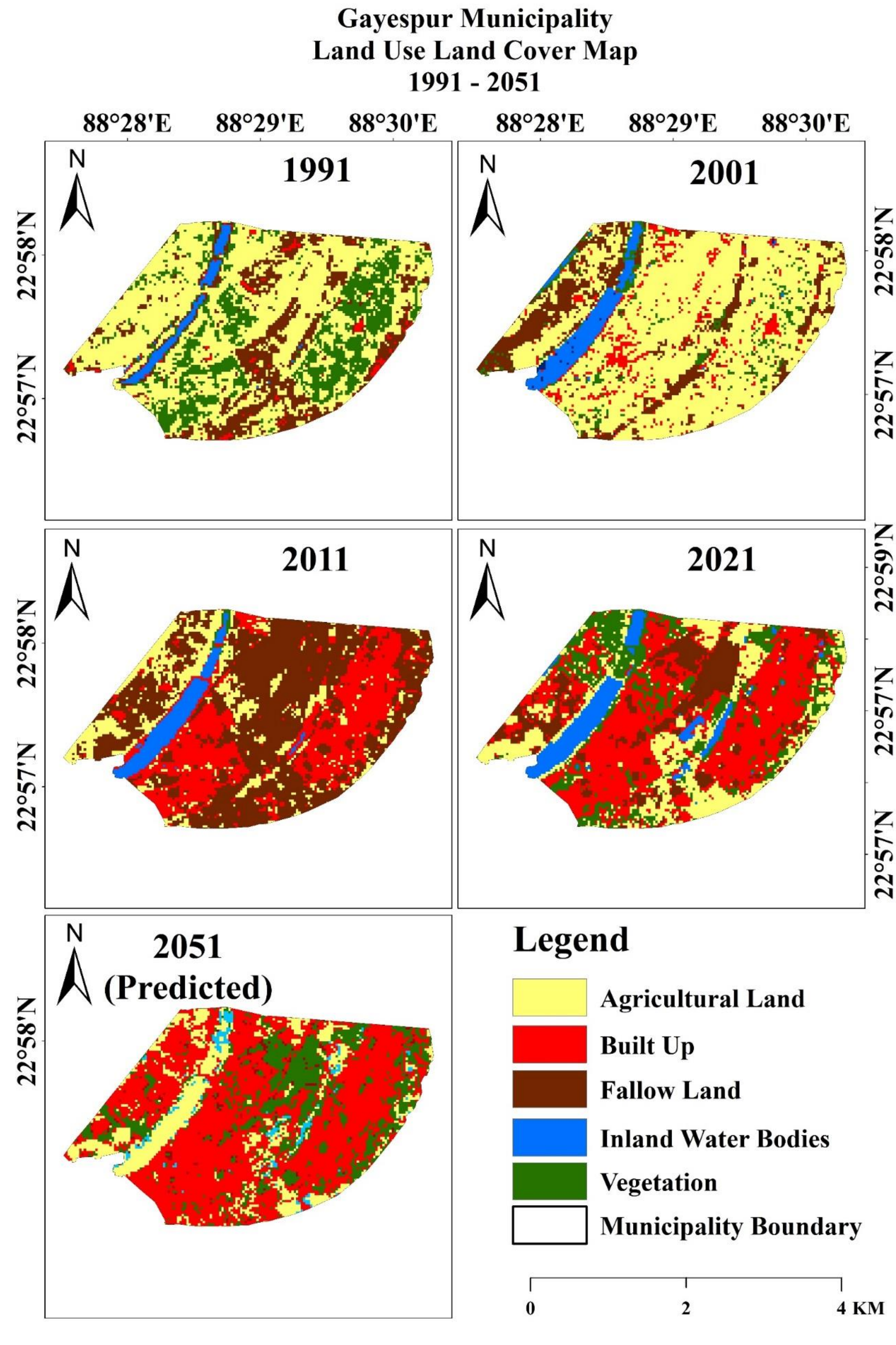


Figure 6. 16: Gayespur Municipality, the pocket shadow zone (Peri-Urban) in KMA area LULC Mapping. Source: Author. Landsat Data Image and GIS Mapping

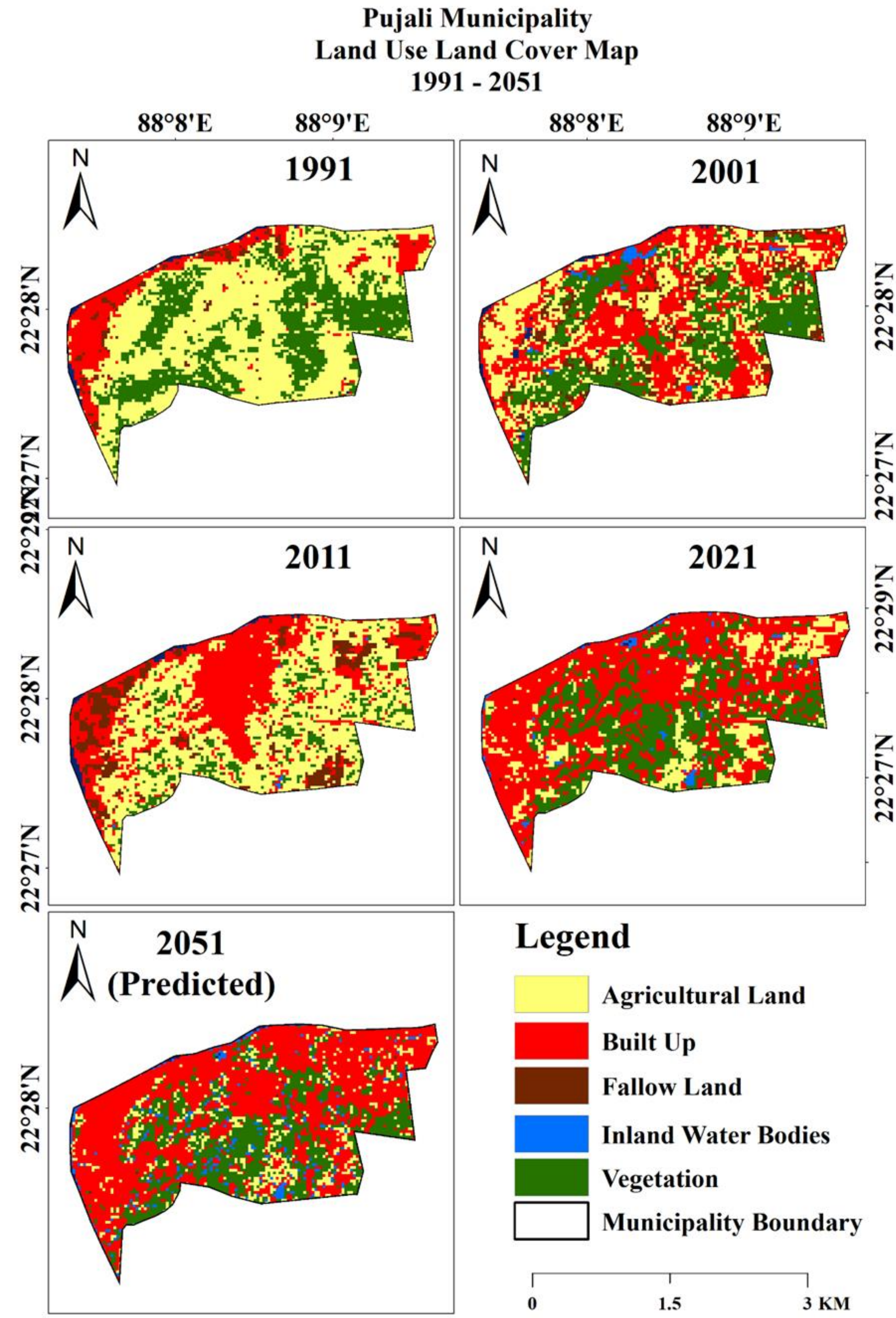


Figure 6. 17 : Pujali Municipality, the pocket shadow zone (Peri-Urban) in KMA area LULC Mapping. Source: Author. Landsat Data Image and GIS Mapping

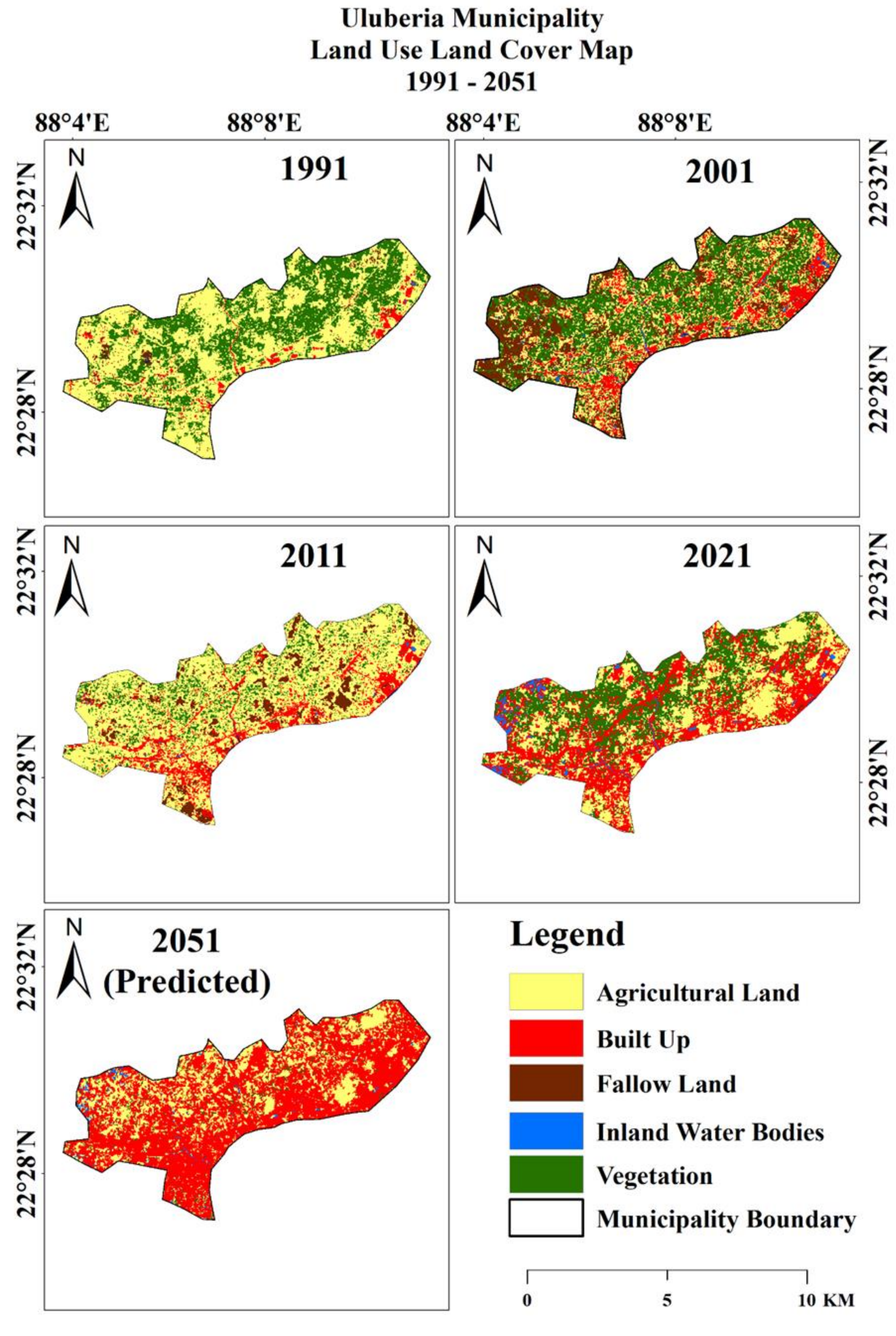


Figure 6. 18: Uluberia Municipality, the pocket shadow zone (Peri-Urban) in KMA area LULC Mapping. Source: Author. Landsat Data Image and GIS Mapping

6.1.6 Urbanistic calculation by Shannon's Entropy

Shannon's Entropy:

Population increase is the primary cause of urban sprawl, and the population is concentrated in the city center yet dispersed throughout the suburbs (Champion, 2001); (Lie & Zhang, 2009). Urban sprawl refers to the unplanned spatial growth of built-up land (Glaeser & Kahn, 2004); (Sudhira, Ramachandra, & Jagadish, 2004); (LGlaeser, Gyourko, & Saks, 2006). Spatial planners, on the other hand, require this knowledge in order to plan for the infrastructure required to address the aspirations of the urban population (Taubenbock, Wegmann, Roth, Mehl, & Dech, 2009). Entropy measures the degree of complexity in a system and is 0 in the case of deterministic occurrences. Shannon's urban entropy compares the geographical concentration and dispersion of built-up land across time (Alabi, 2009); (Mohammady & Delavar, 2015). It is an index that indicates the dispersion of built-up land within a specific spatial unit as a function of the cumulative area of built-up land (Jat, Garg, & Khare, 2007) .

The equation presented by Yi and Li (2001) is used to determine Shannon's Entropy, as illustrated below:

Shannon's Entropy $H_n = -\sum_{i=1}^{n} p_i \log_e(p_i)$ (Eqn. no. 6.1)

Where p_i is the proportion of the variable in the i^{th} zone and n is the total number of zones.

The entropy value varies from 0 to Log (n) Where Log (n) = Maximum limit of Entropy. Here

If the value is near to 0, it signifies that the distribution is very compact while the value closer to Log (n) suggests a more dispersed distribution.

The prevalence of urban sprawl is revealed by a higher value of entropy, as dispersed settlement reveals sprawl. For KMA, Landsat satellite imageries were acquired for a length of time and then processed to classify the image into distinct land cover classifications. Computing urban area from the classified images was employed to determine urban sprawl from 1991 to 2021. For procuring the built-up area pixels from the data set, object-based classification was performed in an iterative manner in this research. To estimate the changes in the built-up area, the decadal difference between urban built-up areas was estimated. Buffer rings were built around the primary city center at intervals of 1 km to 3 km, 5km, and 7km for Baruipur, and Pujali, Gayespur, and Uluberia respectively which were then subdivided into eight zones i.e. north, south, east, west, north-east, north-west, south-east, south-west. For each ring, urban areas were extracted in order to compare growth over time for each ring. The Shannon's entropy value was determined for all three rings and the eight zones, which were then compared to see how urban expansion has changed over time in relation to distance from the city center. A visual survey was also carried out to check the ground truth and to confirm the relationship between the entropy value of different zones and the built-up regions within the four unsaturated municipal areas.

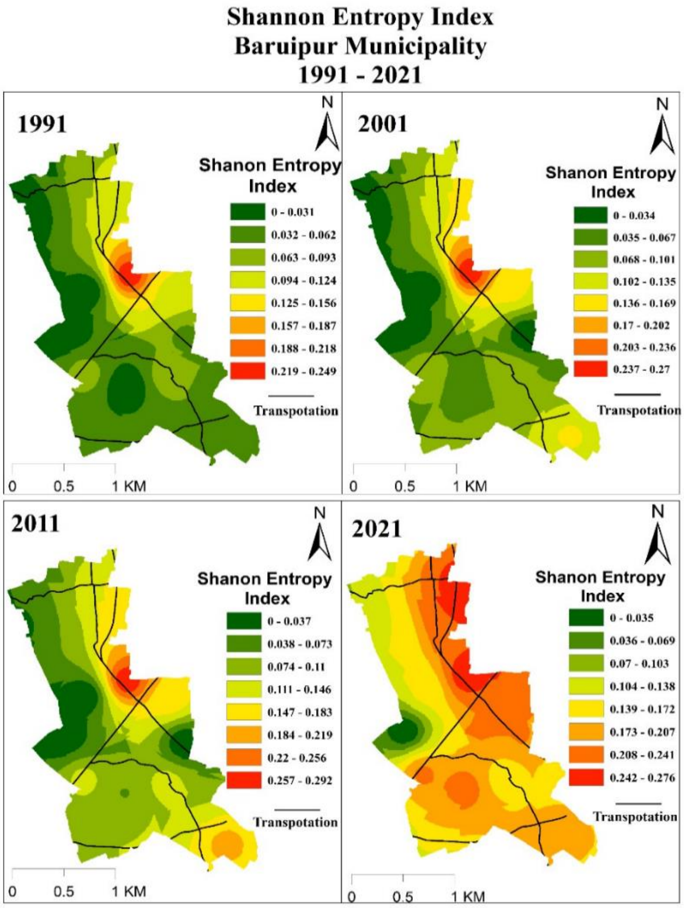
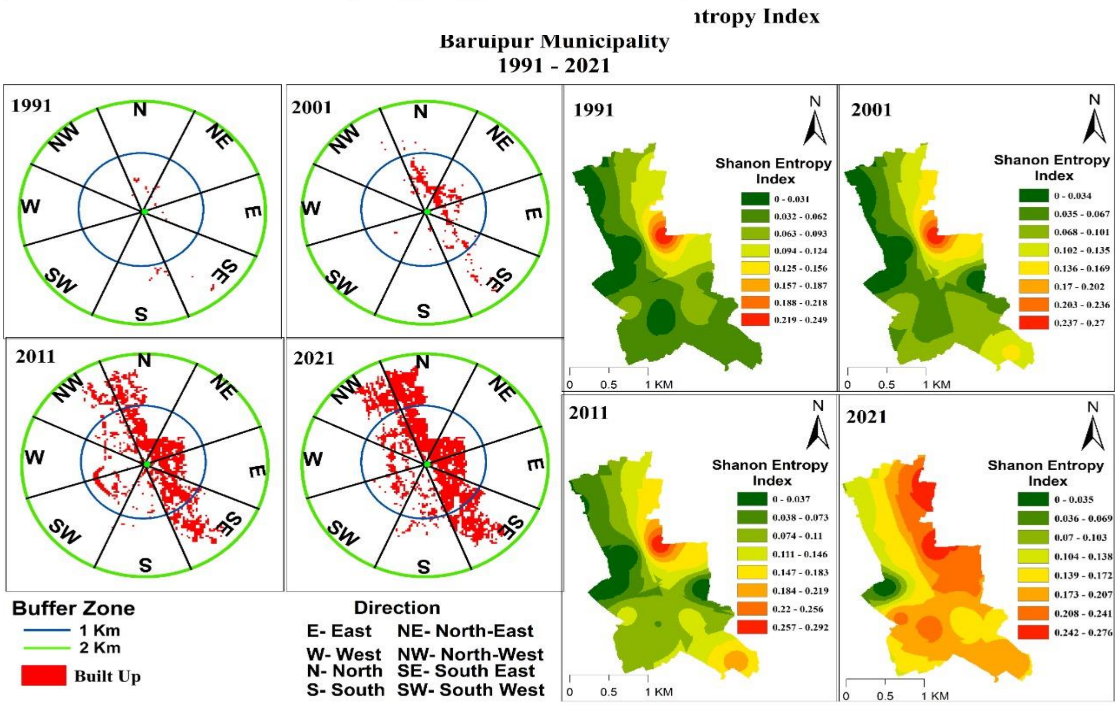


Figure 6. 19 Shannon Entropy Index calculation for Baruipur Municipality
Source: Author



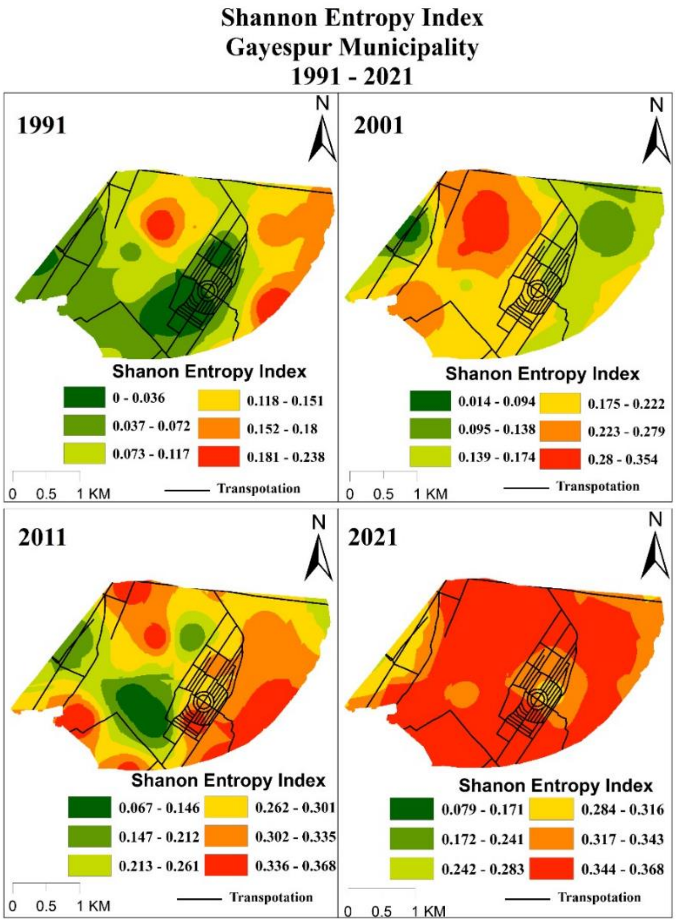
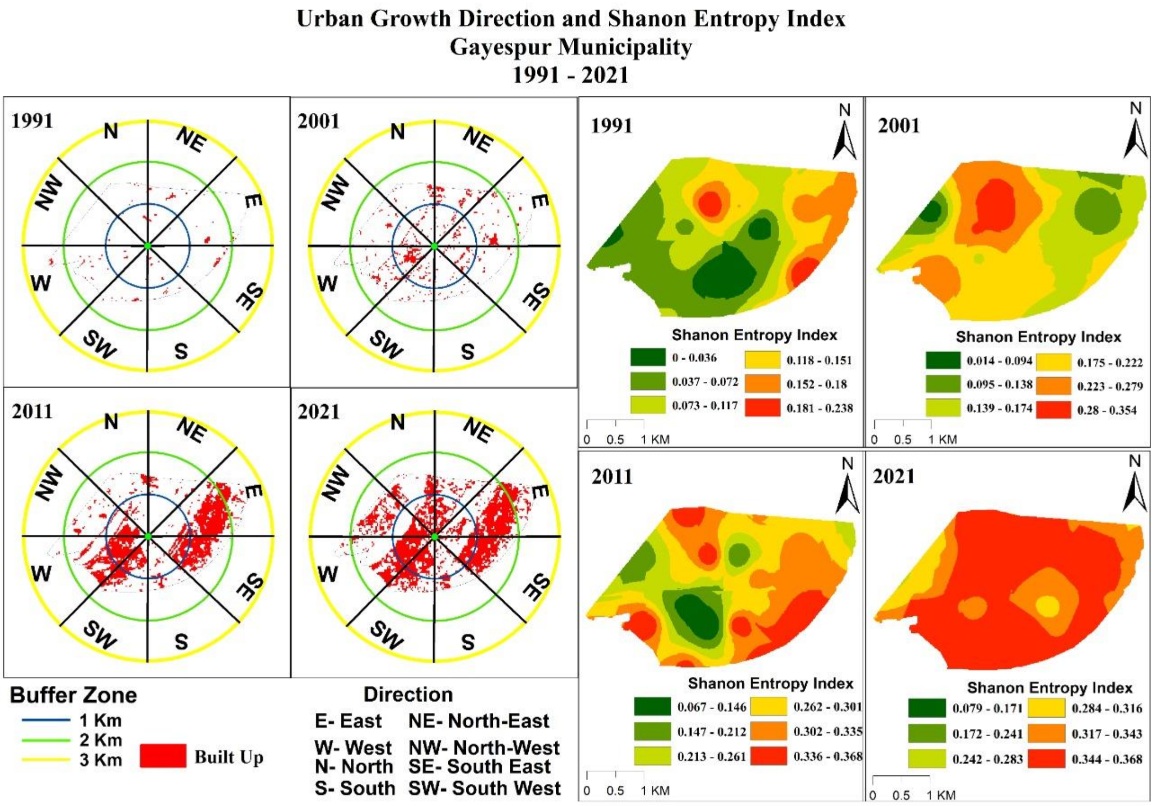


Figure 6. 20 : Shannon Entropy Index calculation for Gayespur Municipality



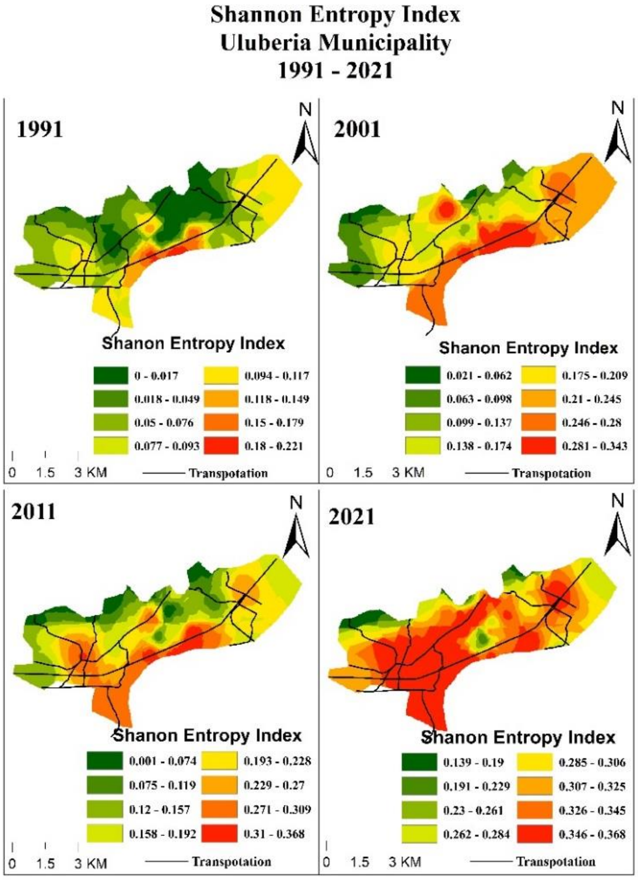
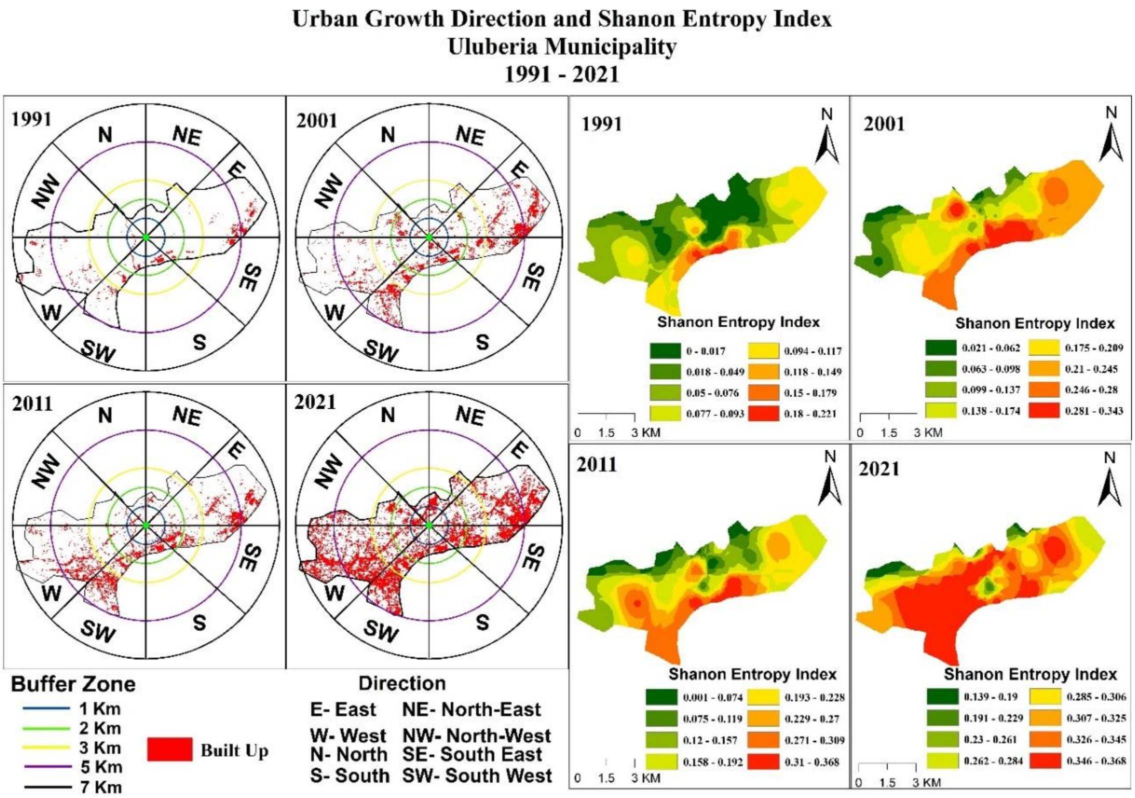


Figure 6. 21: Shannon Entropy Index calculation for Uluberia Municipality
Source: Author



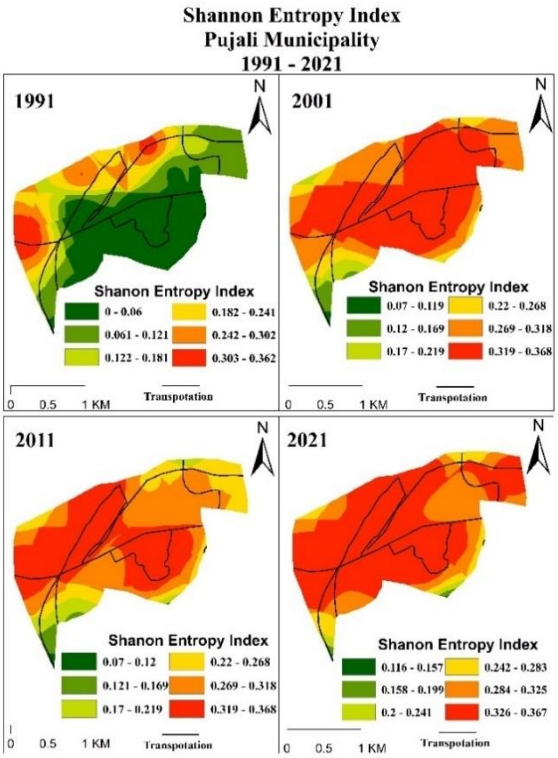
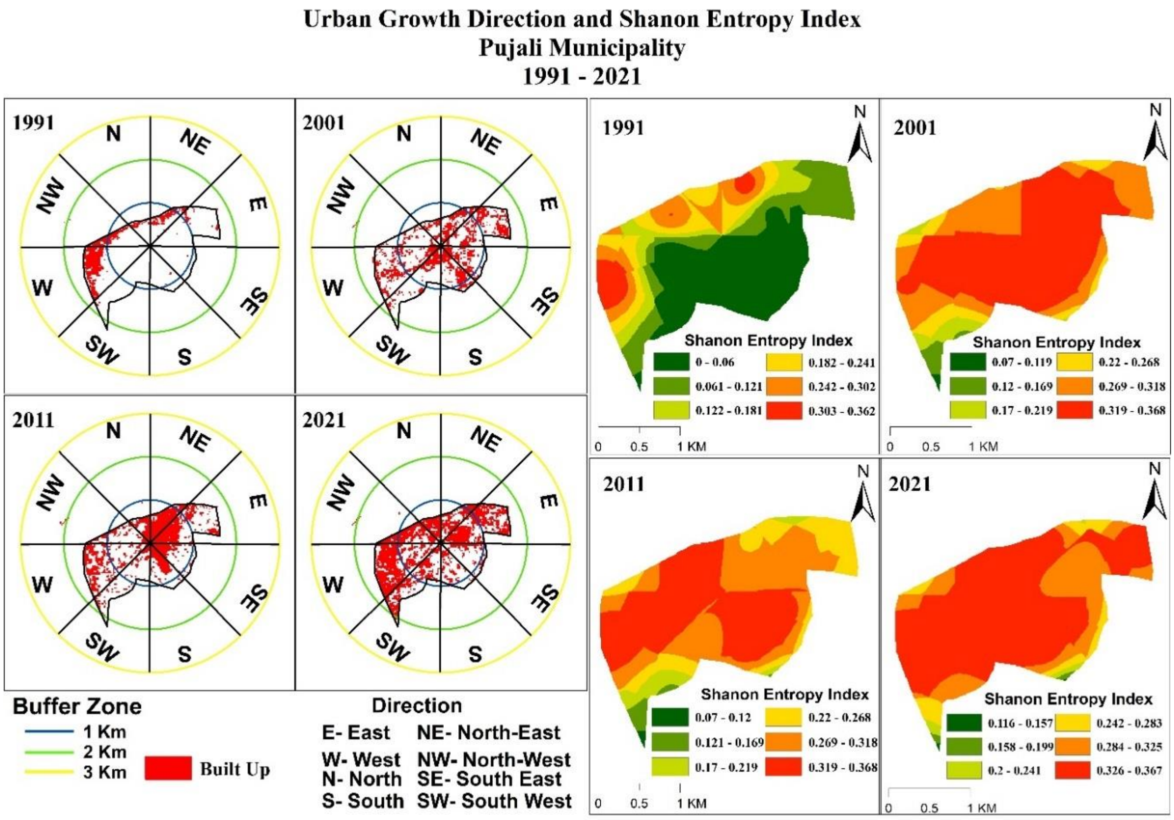


Figure 6. 22 : Shannon Entropy Index calculation for Baruipur Municipality . Source: Author



6.1.7 Urbanistic calculation by Chi-Square

Pearson's chi-square and urban growth:

The Pearson Chi-square test was performed in this analysis to compute and evaluate the urban expansions. Since this section of the analysis illustrates the urban growth, therefore, the classified Landsat satellite imageries along with the builtup pixels were only taken into account. Moreover, to identify the growth more efficiently, the classified temporal images of the four unsaturated municipal zones were subdivided into eight direction namely, north, south, east, west, northeast, northwest, southeast, and southwest. Thereafter the Pearson Chi-square test was employed.

The Pearson's chi-square distribution is used to represent changes in land use within the same class (Almeida, et al., 2005) by utilizing the freedom between variable pairs employing the following relation:

$$D = (Observed\ growth - Expected\ growth)^2 / Expected\ growth \qquad \text{(Eqn. no. 6.2)}$$

Where, D = degree of freedom.

This relationship depicts the degree of freedom or variance between observed and expected urban growth. Based on Eq.6.2, the Chi-square statistical relationship has been determined for each time span of (X_i^2).

$$D_i^t = \sum_i^n D_i^z \qquad \text{(Eqn. no. 6.3)}$$

Where, D_i^t denotes the degree of freedom of growth for the i-th temporal span, D_i^z represents the degree of freedom of growth for the i-th zone in the same time span,

To compute the degree of freedom for each zone the following equation was employed.

$$D_i^z = \sum_i^n D_i^t \qquad \text{(Eqn. no. 6.4)}$$

Furthermore, by combining the degrees of freedom of all time periods or integrating the degrees of freedom of all zones, the overall or inclusive degree of freedom of a research area can be determined.

The lower limit of Chi-square is 0 which signifies that the observed growth and expected growth value are identical.

Table 6. 7 : Degree of freedom and urban expansion at 30 years' time scale

Sl. No.	Municipality name	Time period	Degree of freedom
1	Baruipur	1991 to 2021	0.22
2	Pujali	1991 to 2021	1.25
3	Gayespur	1991 to 2021	2.33
4	Uluberia	1991 to 2021	3.09

Table 6.7 demonstrates the degree of freedom for thirty years for the four unsaturated zones i.e. Baruipur, Pujali, Gayespur, and Uluberia.

From the above table the maximum degree of freedom value was found in Uluberia, while the lowest was found in Baruipur. In general, a higher degree of freedom, in general, indicates to the requirement for consistency in the planning, management, and control of urban growth throughout the study area. Higher degree of freedom for a zone is a warning sign indicating imbalanced growth within the zone over time. In this study. Uluberia exhibited the highest degree of freedom, indicating that its expansion was uneven throughout time. Higher degrees of freedom over time can be equated to greater inter-zone inconsistency in urbanization. However, we should not think of a higher degree of freedom as sprawl, but rather as a discrepancy in urban expansion.

The degree of freedom calculated through this method show that almost all four micro level study areas do not have any haphazard growth tendencies, but all the major growths are concentrated along the major road and suburban railway stations.

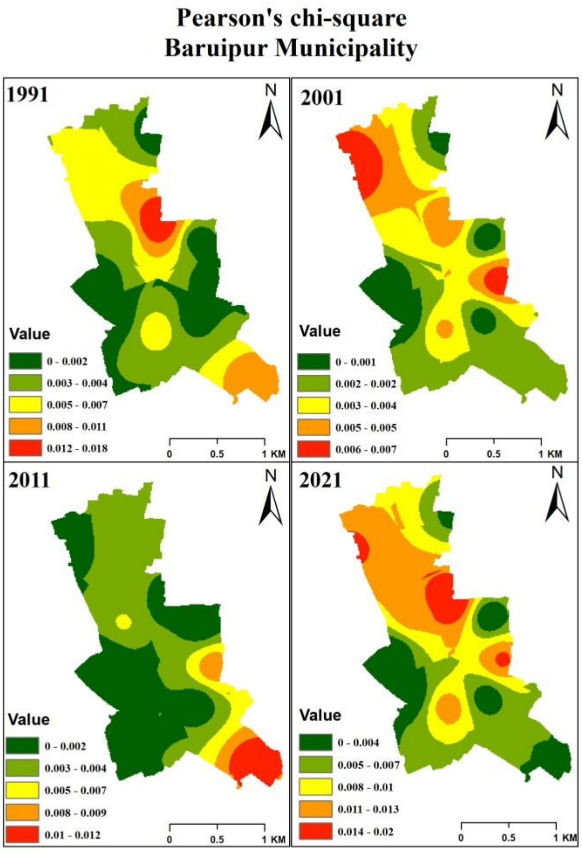


Figure 6. 24: Chi Square Mapping for Baruipur
Source: Author

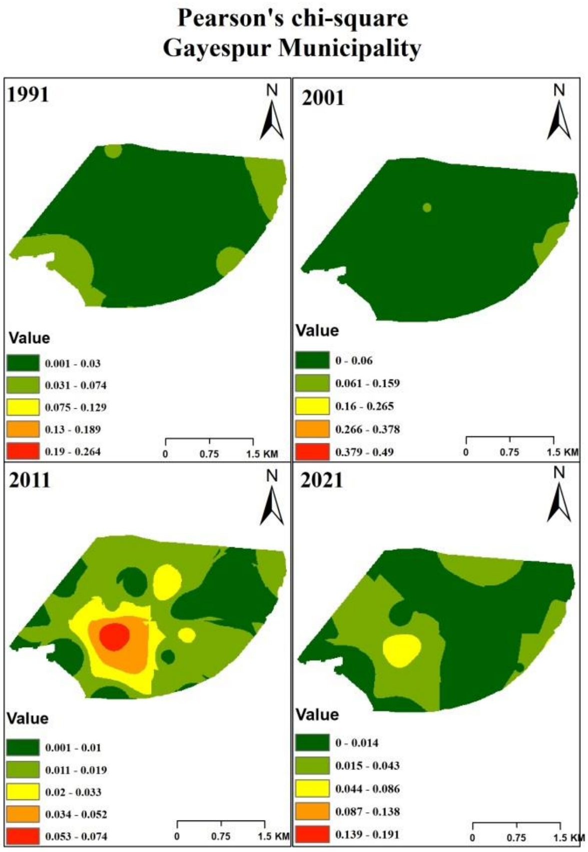


Figure 6. 23: Chi Square Mapping for Gayespur
Source: Author

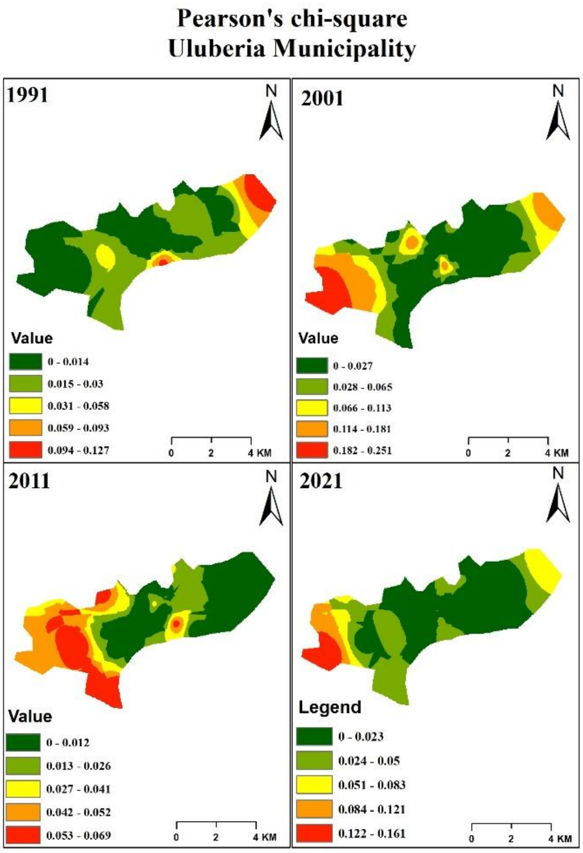


Figure 6. 26: Chi Square Mapping for Uluberia
Source: Author

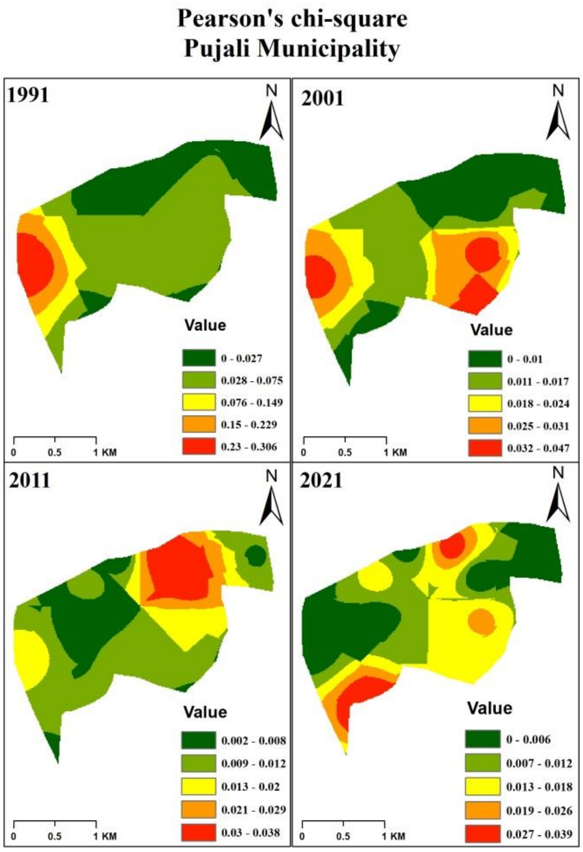


Figure 6. 25: Chi Square Mapping for Pujali
Source: Author

6.2 Weightage index and composite score analysis of urbanization indicators in unsaturated areas

Using census data to demarcate the peri-urban area yields adequate findings. According to the findings, there are a few similar variables that can be used as indications of urban effect on the surrounding rural. As a result, deciding the indicators of peri-urban region delimitation will be a prudent decision. Demographic characteristics, socioeconomic development, public service provision, and the share of non-agricultural people are the key variables used to define the peri urban area. Three determinants were used to determine the geographical extent of the peri urban area.

The three sets of indices for delineating the peri urban areas are as follows:

1. **Demographic Features:**

i) Population density

ii) Decadal growth rate

iii) Literacy rate

2**. Occupational Structures:**

i) Female workers

ii) Non-agricultural workers

3. Infrastructure

i) Market availability

ii) Road network development

iii) Bus services

1. Demographic Features: The following determinants are selected from the demographic structure to demarcate the peri urban areas.

People density: The density of the population is a reliable indicator of the city's influence. Both skilled and unskilled rural residents are forced into peri-urban regions for education, work, and other utility services, yet they cannot afford to pay exorbitant rent and must live on the outskirts of the city.

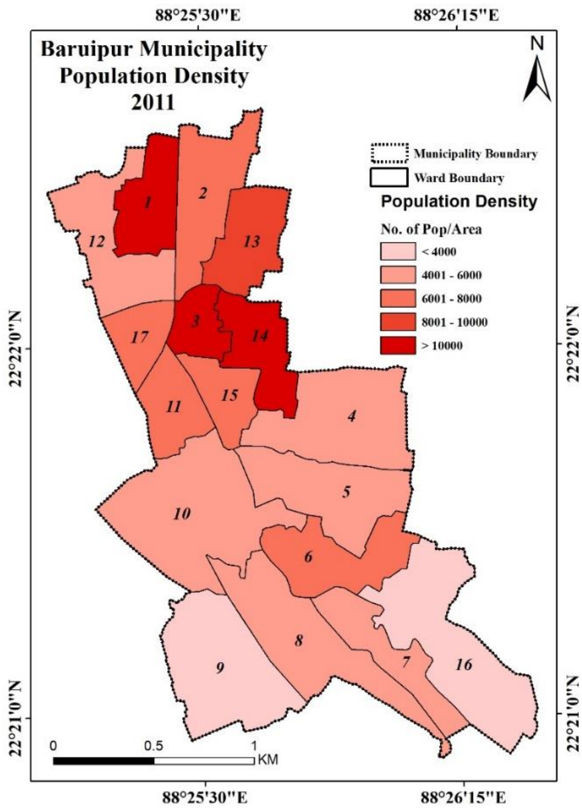


Figure 6. 27 : Population Density 2011 mapping Baruipur Municipality
. Source: Author

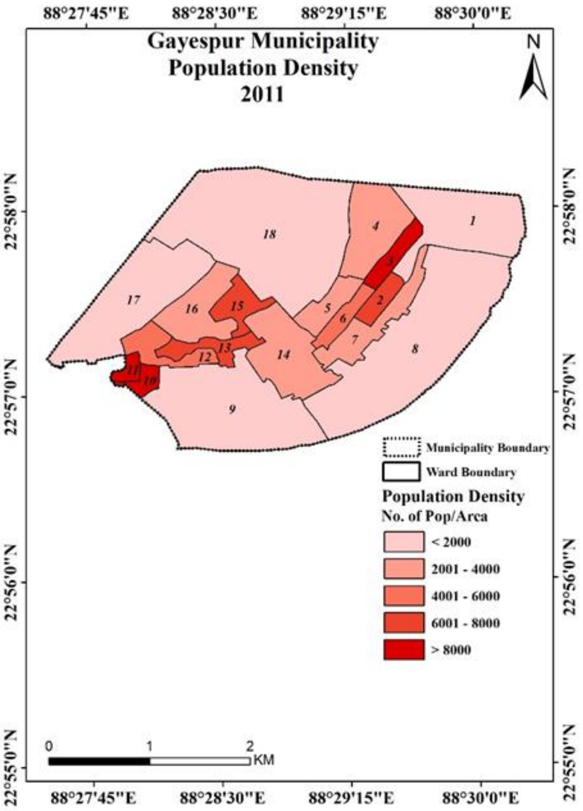


Figure 6. 28: Population Density 2011 mapping Gayespur Municipality Source: Author

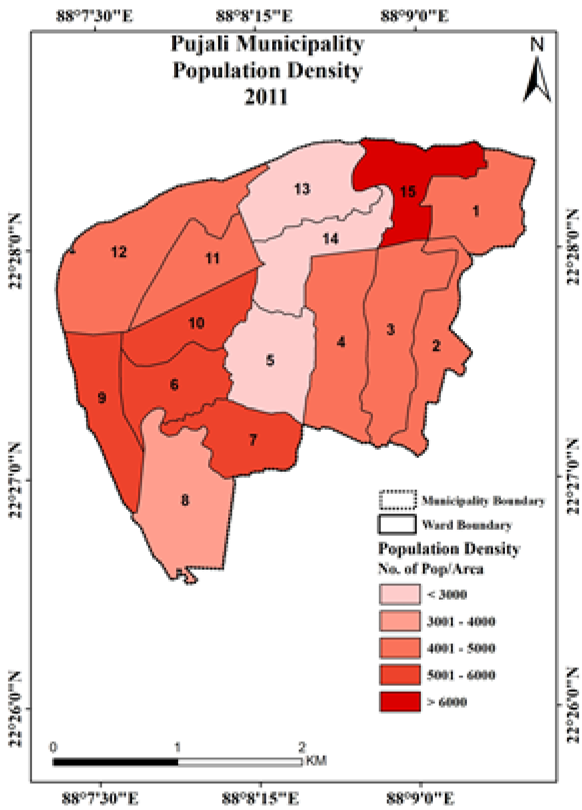


Figure 6. 28: Population Density 2011 mapping Pujali Municipality Source: Author

The mean density of Baruipur is 5600 persons per sq. km. (Census of India 2011). This average density has been taken as the lower mark for fixing the inner or outer limit of peri-urban area. It has seen that about 3 wards have the population density of 10000 persons per square kilometre.
The mean density of Gayespur is 1966 persons per sq. km. (Census of India 2011). This average density has been taken as the lower mark for fixing the inner or outer limit of peri-urban area. It has seen that about 3 wards 1, 10, 11 have the population density of 8000 persons per square kilometre.
The mean density of Pujali is 4452 persons per sq. km. (Census of India 2011). This average density has been taken as the lower mark for fixing the inner or outer limit of peri-urban area. It has seen that about 1 wards-15 have the population density of 6000 persons per square kilometre & 4 wards have population density above 5000 persons per square kilometre.

Decadal growth rate: Like density, decadal population growth is also an important factor for delimiting the peri-urban area.

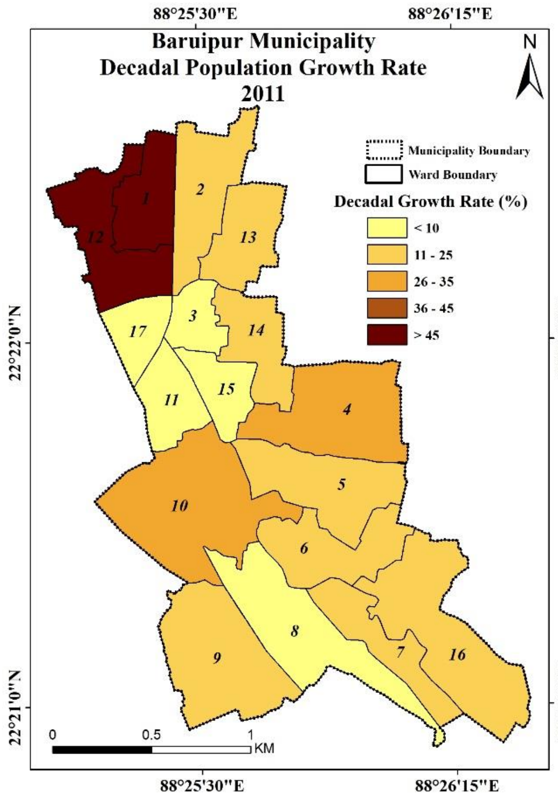


Figure 6. 30: Decadal Growth Rate 2011 mapping Baruipur Municipality
Source: Author

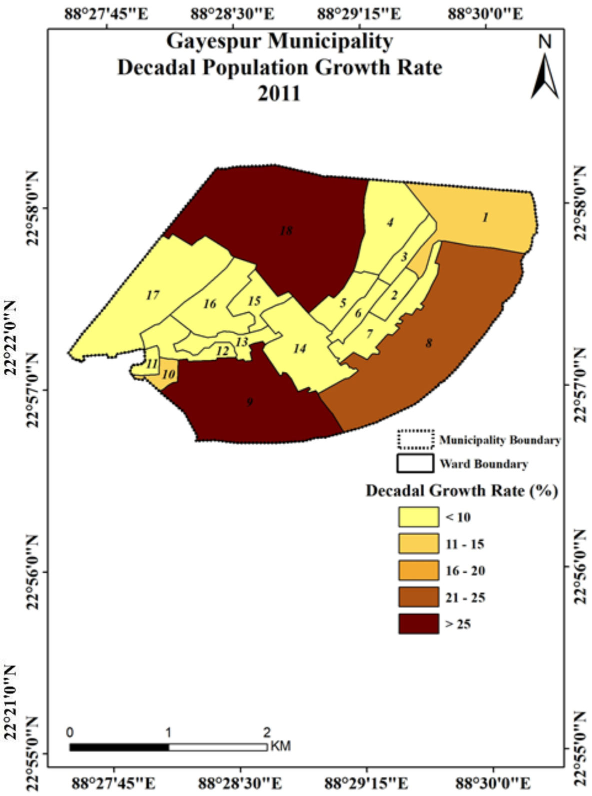


Figure 6. 29 : Decadal Growth Rate 2011 mapping Gayespur Municipality
Source: Author

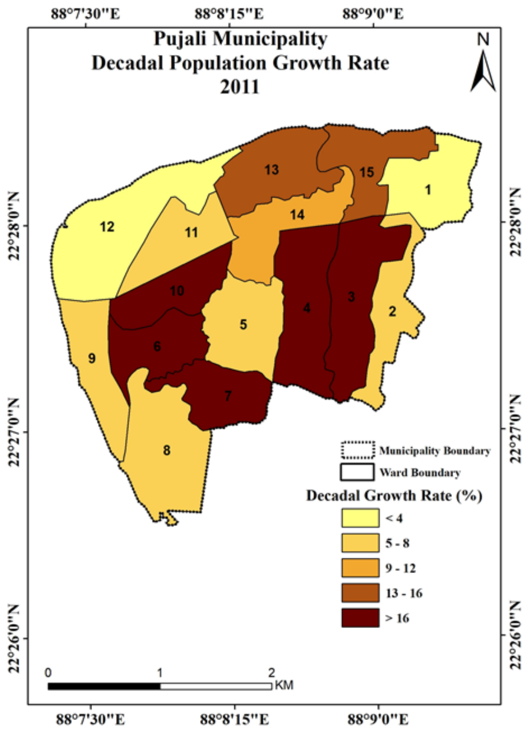


Figure 6. 31: Decadal Growth Rate 2011 mapping Pujali Municipality
Source: Author

29 percent growth during the year 2001-11 has been taken to different wards of Baruipur. The selection of the value based on the average growth of wards.2 out of 17 wards are above the 45 percent or more growth during this period. There is a greater tendency for increase of growth to different wards of Baruipur.

20 percent growth during the year 2001-11 has been taken to different wards of Gayespur. The selection of the value based on the average growth of wards.2 out of 17 wards are above the 25 percent or more growth during this period.

12 percent growth during the year 2001-11 has been taken to different wards of Pujali. The selection of the value based on the average growth of wards.5 out of 15 wards are above the 16 percent or more growth during this period.

Literacy rate: It has observed that the area nearer the part of city from CBD will be more educated and literate than those further away. The highly educated society of the city affecting and transforming the traditional and old living style of the peri-urbans.

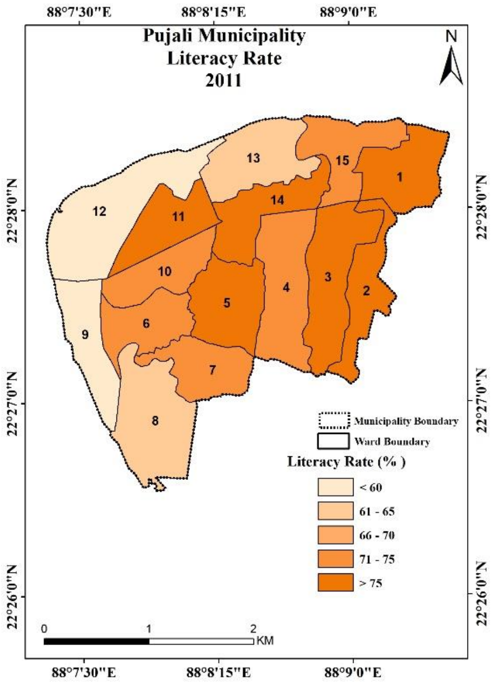


Figure 6. 33 : Literacy rate 2011 mapping Pujali Mnicipality
Source: Author

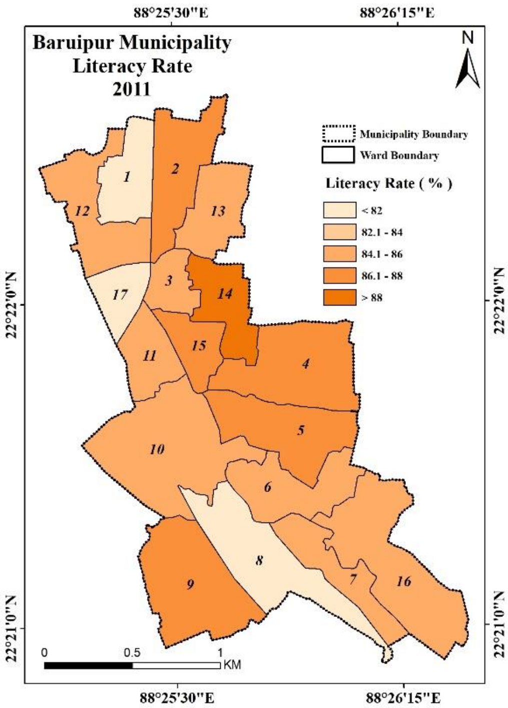


Figure 6. 32 : Literacy rate 2011 mapping Baruipur Mnicipality
Source: Author

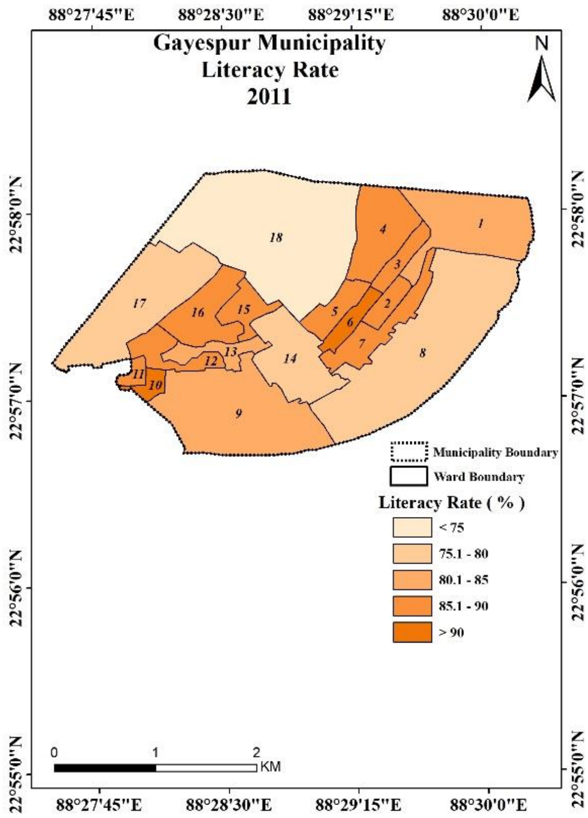


Figure 6. 34: Literacy rate 2011 mapping Gayespur Mnicipality
Source: Author

About 16 wards out of 16 are above 80 percent literacy rate in peri urban area of Baruipur.

About 11 wards out of 15 are above 70 percent literacy rate in peri urban area of Pujali.

About 17 wards out of 18 are above 75 percent literacy rate in peri urban area of Gayespur. Hence, the literacy rates are found to be inversely proportional to the distances from CBD for peri-urban areas.

2. Occupational Structures:

In the peri-urban area, occupation is one of the most essential aspects. People nearby to Kolkata are involved in non-agricultural occupations. These habitats reside in the peri-urban areas of Baruipur, Gayespur, and Pujali, but they do not engage in agricultural activities.

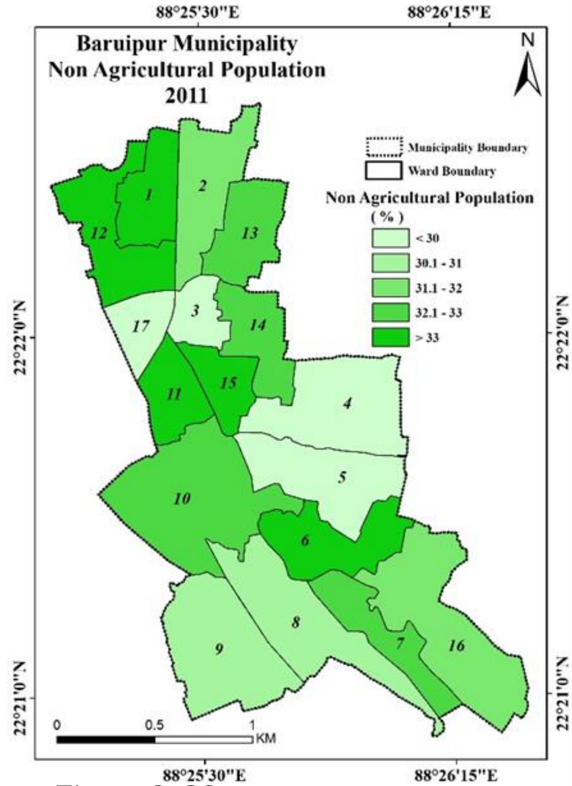


Figure 6. 36: Non-agricultural population 2011 mapping Baruipur municipality Source: Author

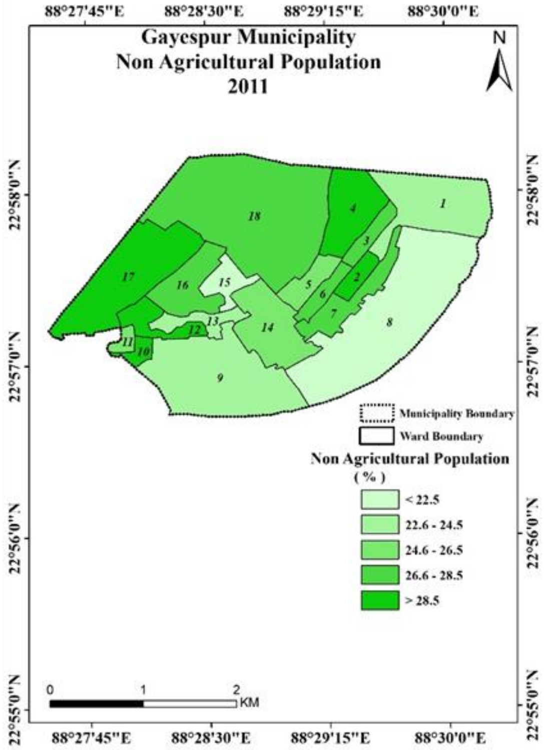


Figure 6. 35: Non-agricultural population 2011 mapping Gayespur municipality
Source: Author

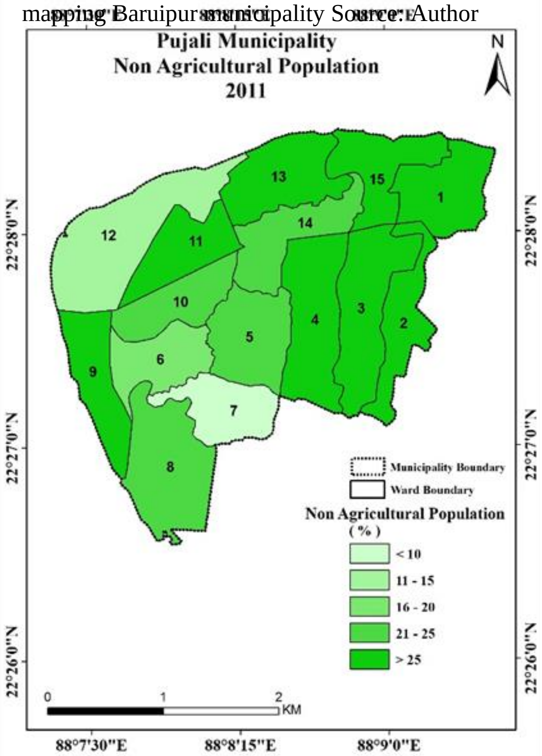


Figure 6. 37:Non-agricultural population 2011 mapping GAyespur municipality Source: Author

Female workers: One of the important variables in defining peri-urban communities is female labor participation. Continuous migration of the population from the rural areas to Kolkata and its peri-urban areas in search of employment has engaged women in different works.

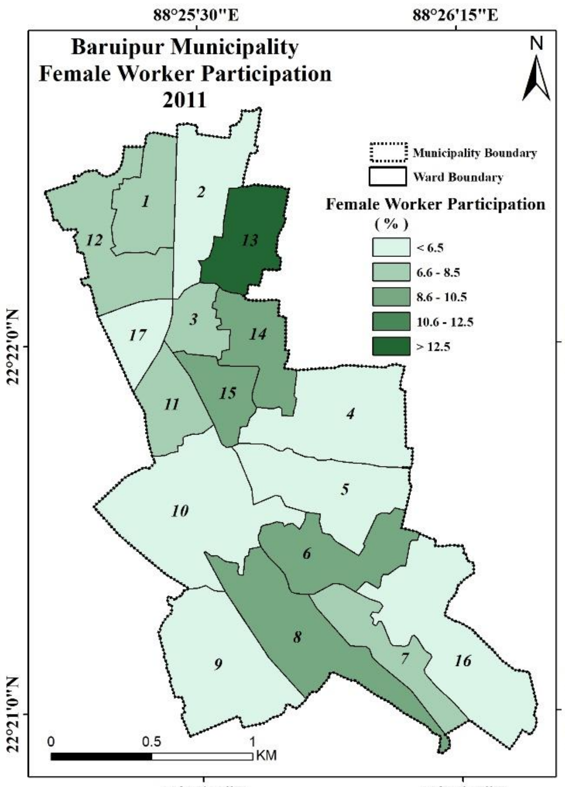


Figure 6. 39: Female worker participation 2011 mapping Baruipur Municipality Source: Author

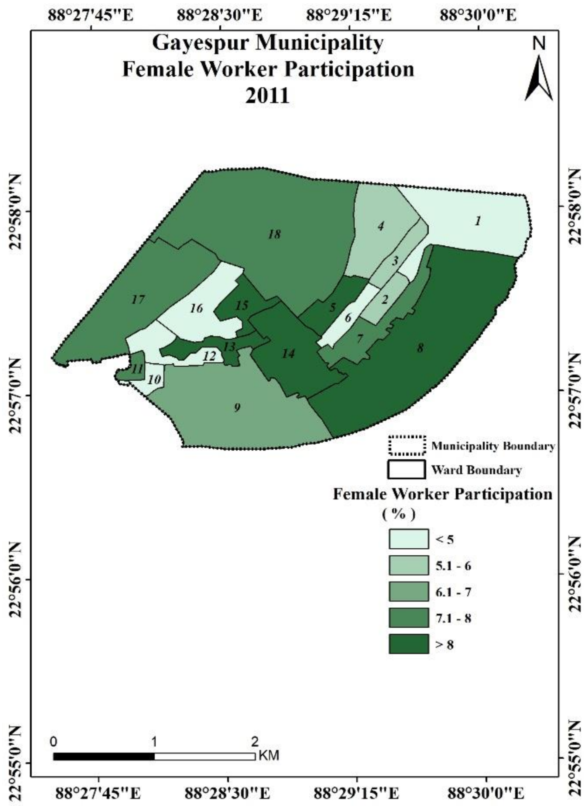


Figure 6. 38: Female worker participation 2011 mapping Gayespur Municipality Source: Author

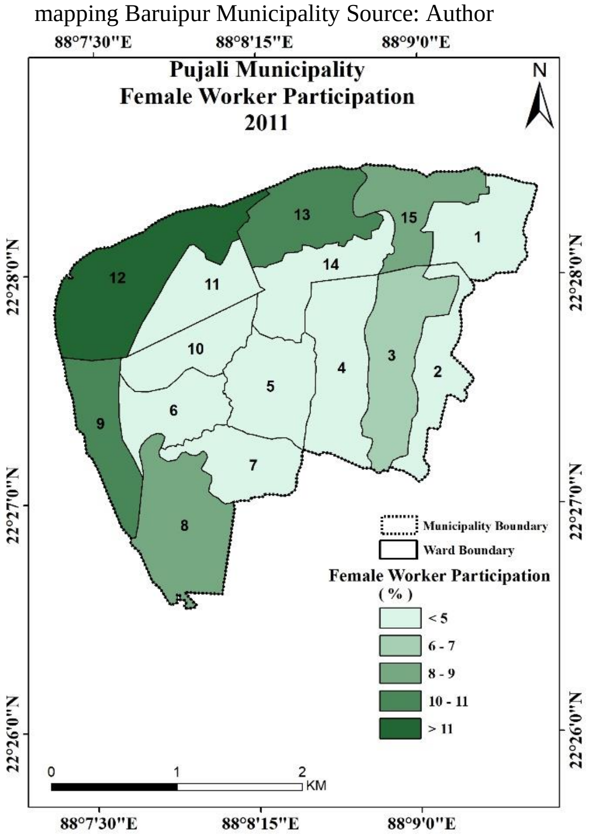


Figure 6. 40: Female worker participation 2011 mapping Pujali Municipality Source: Author

The percentage of women who work has been chosen as an indicator of the size of the inner or outer peri-urban area. Women are more likely to work in wards located outside of the city. Because these people came to the city to work in various domestic jobs. Work involvement is strong in several wards, such as 13,14,1,10,6, 8. The more the engagement of women in the labor force, the greater the women's empowerment. Female work participation is more in Gayespur as the distance of this municipal area is more from Kolkata in comparison the other study areas.

3. Infrastructure

Market availability:

One of the most important indicators used to define the peri-urban area is market availability. The market area within 1 km of the ward has more effect than the market area further away. All the wards of 4 selected study areas have availability of market within 1 km distance which have a steady growth rate due to effect of globalization & demand of increasing urban population.

Black topped road:

One of the most important components in urban development is roads. The availability of a black-topped road has improved access to the city. Road networks change into a variety of spatial patterns as they grow and deteriorate throughout time. All these 4 selected peri-urban study areas are situated on major arterial roads or national highways connecting them to Kolkata & other KMA areas. All the wards of these municipal areas have black top road network for internal connectivity.

Bus service availability:

Because there is a close contact between the city and the flow of traffic on roads focused on it, this service has been widely used in the delimitation of peri-urban areas. The majority of the wards in our chosen research regions are well-served by public transportation. As a result, wards having bus service are classified as inner per-urban.

The quantitative value of the above mentioned infrastructures could not be assessed due to limitation in data but during the survey of LULC the qualitative analysis has been addressed.

6.2.1. Correlation analysis of indices of urbanisation indicators:

6.2.1.1 Correlation Analysis: Karl Pearson devised the correlation coefficient formula as a measure of the strength or degree of association between two variables. The purpose of this study was to determine the association between distance from the city center and several characteristics such as literacy rate, non-agricultural employees, decadal growth rate, and female workers.

Pearson's Correlation Coefficient

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

Where,

r = Pearson Correlation Coefficient

x_i = x variable samples y_i = y variable sample

$\bar{x}$ = mean of values in x variable $\bar{y}$ =mean of values in y variable

Variables	Correlation Values
Literacy Rate	0.182
Non Agriculture Workers	0.111
Decadal growth rate	-0.025
Female workers	-0.070

Table 6. 8 : Correlation of different indicators for Baruipur. Source (Author)

Variables	Correlation Values
Literacy Rate	-0.347
Non Agriculture Workers	-0.482
Decadal growth rate	-0.071
Female workers	-0.414

Table 6. 9 : Correlation of different indicators for Gayespur. Source (Author)

Variables	Correlation Values
Literacy Rate	-0.062
Non Agriculture Workers	-0.243
Decadal growth rate	0.146
Female workers	0.196

Table 6. 10 : Correlation of different indicators for Pujali Source (Author)

Above tables reveal that there exists negative correlation between the distance from the city and literacy i.e. r = – 0.347 in table 6.9. It is quite convincing also that with the increasing distance the literacy level decreases.

Correlation between the distance and non-agricultural workers is equal to r = 0.111 in table 6.8. It is evident that increase in percentage of non-agricultural workers with the decreasing distance from the city limits.

Correlation between distance from the city and decadal growth rate is r = - 0.071 in table 6.9. It is clear from the table that with the increasing distance from the city the decadal growth rate goes on decreasing.

Another correlation between distance and female workers is to r = 0.414 in table 6.9. These two variables are positively correlated with each other. It shows that there is almost corresponding increase in female workers with increasing distance from city centre.

6.2.1.2 Correlation -Composite Score Mapping of urbanization indicators in unsaturated areas :

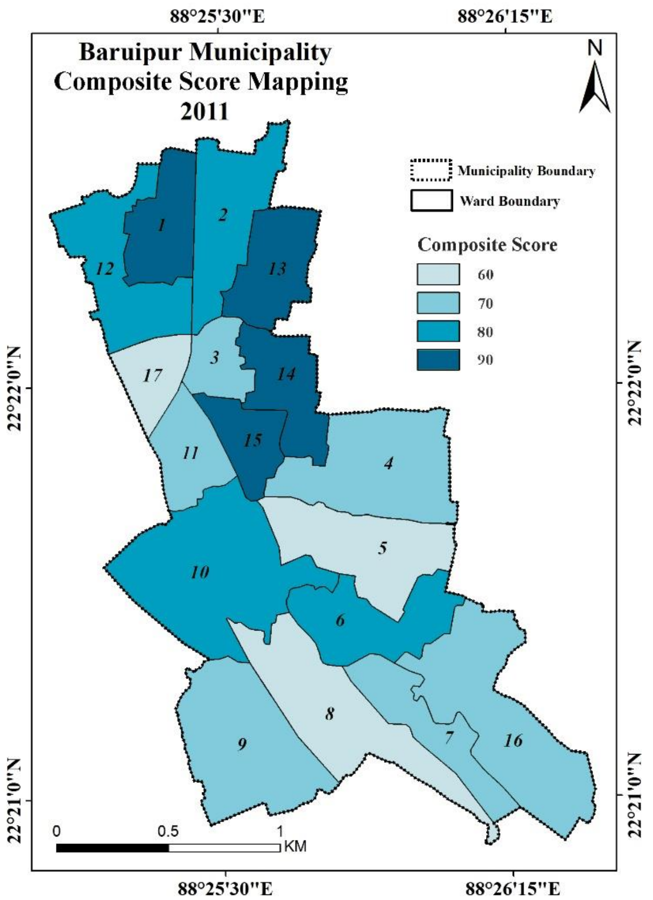


Figure 6. 42Composite score mapping of Baruipur Municipality 2011 Source: Author

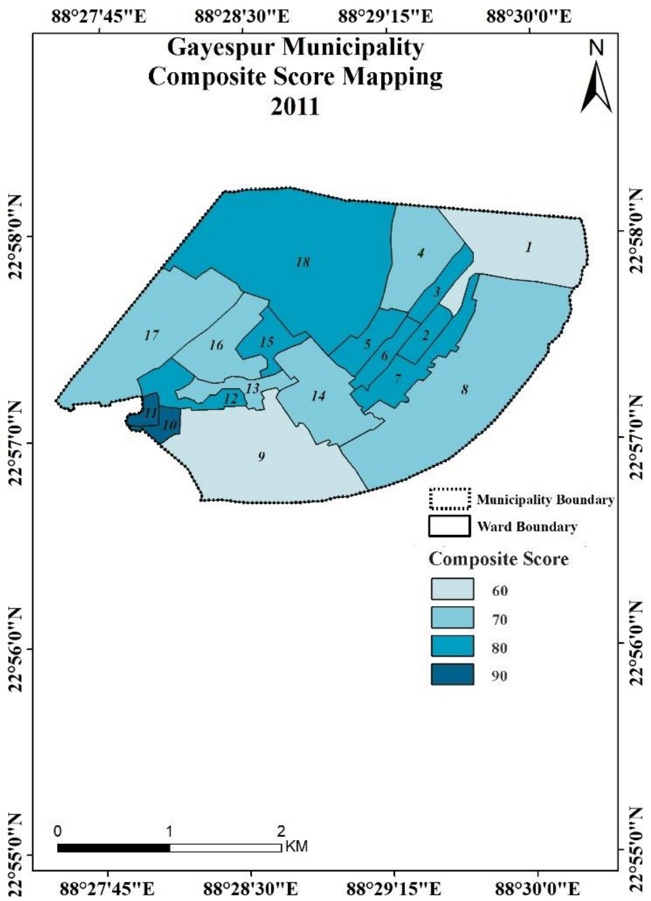


Figure 6. 41Composite score mapping of Gayeshpur Municipality 2011 Source: Author

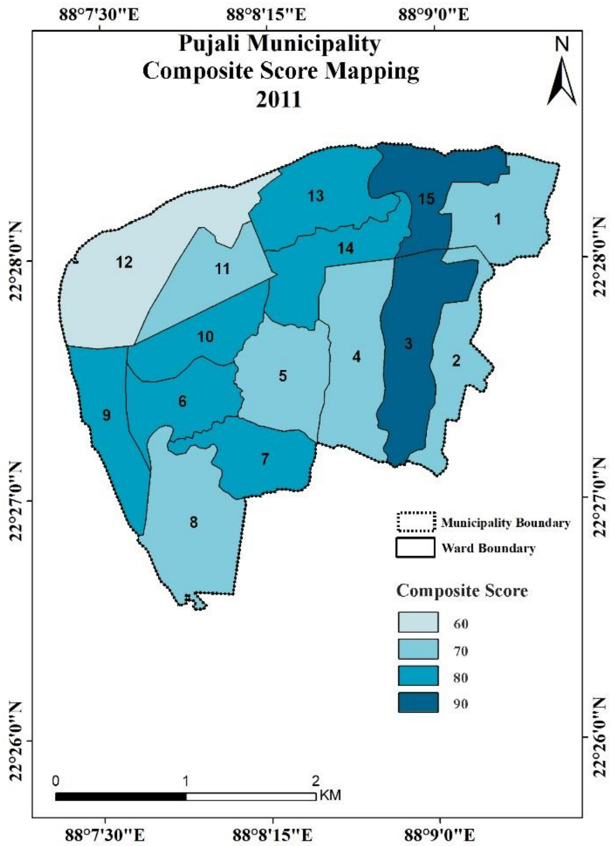


Figure 6. 43Composite score mapping of Pujali Municipality 2011 Source: Author

From composite score mapping we can identify which wards are highly saturated in comparison with other words, and the city shape can also be derived out of it.

1. Baruipur is developing mostly in linear form, where the pull factor is SH1 & Baruipur Sub-urban railway station. Accordingly around this infrastructure ward no 1, 13 14, & 15 are achieving higher saturation level. And the land price over here is also escalating
2. Gayespur is developing in a radial form , concentrating on the central commercial district. The positive point about Gayeshpur is that this area has a well connected pre planned road network resulting in a moderately equal distribution of population.
3. The form of development seen in Pujali is mostly sporadic. The growth majorly concentrates on Pujali main road, resulting in most saturation in ward no. 3 & 15. Secondary road network between Budge Budge trunk road and Pujali road calls for augmentation. Along the river Ganges , the existing defunct industrial area can be utilised for mixed use development to revitalise the economy.

6.2.1.3 comparison of urbanization indicators (correlation) of un-saturated areas with KMA and KMC:

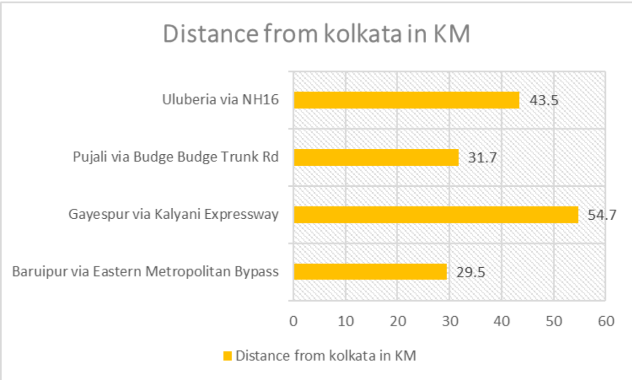


Table 6. 11Distance from Kolkata in Km. of unsaturated zones, Source: Author

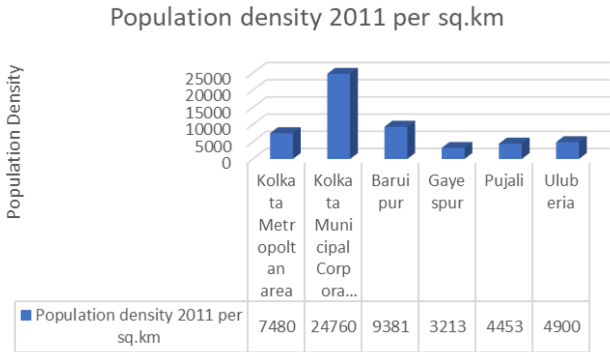


Table 6. 12comparison of population density 2011, Source Author

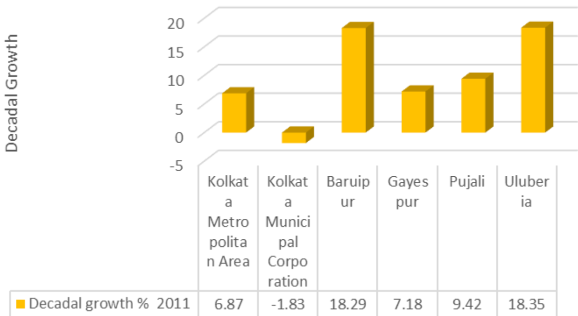


Table 6. 13comparison of Decadal Growth 2011, Source Author

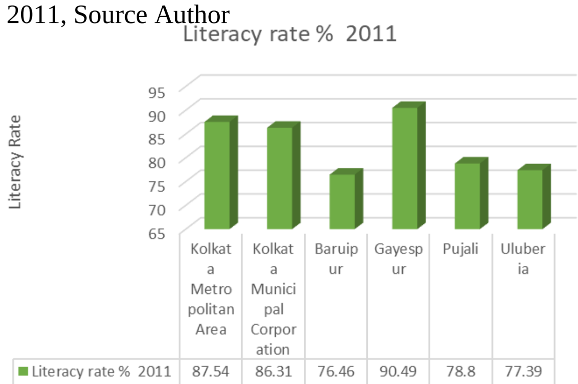


Table 6. 14comparison of Literacy rate 2011, Source Author

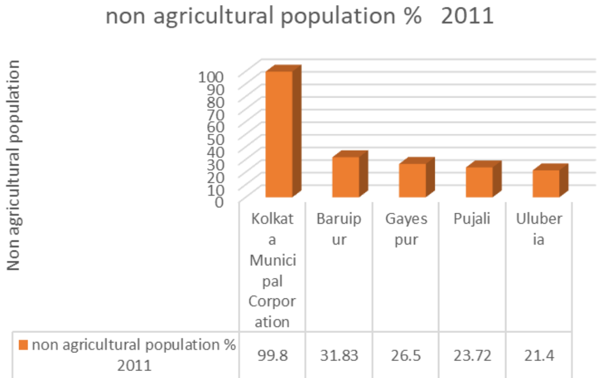


Table 6. 16comparison of Non-agricultural population2011, Source Author

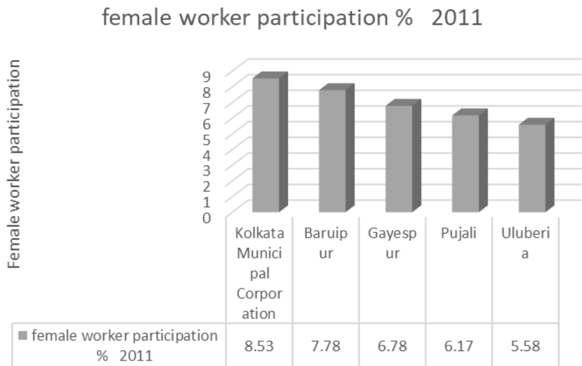


Table 6. 15comparison of female worker participation 2011, Source Author

1. Baruipur & Uluberia are more urbanised than Pujali and Gayeshpur, as they are located near to the City centre.
2. Interventions in Baruipur and Uluberia is more critical as augmentation of infrastructure is difficult over here.

3. Gayeshpur is in advantageous position as it is located near to the planned city of Kalyani and also is a pre-planned township. Here literacy rate is quite higher than other areas of KMA.
4. In case of Gayespur and pujali availability of land is there for planned development.

6.3 Conclusion

These per-urban municipal cities undergo a process of change in physical as well as socio-economic. These areas have predominantly active in non-agricultural activities. All the above indicators are plotted on the map by analysing the composite score analysis. There is a zone where most of the variables subsist in the space where as some wards are co-existing of few indicators. All those wards which have fulfilled at least four indices from above analysis are included in peri urban area of Kolkata. Among four indicators two from demographic, and two from the occupational structure.

6.3.1 Baruipur

Growth Analysis: A rise in the absolute size of an urban population in this settlement area is indicator of Growth. As per municipal DDP the population density, decadal growth, house hold density have increased during 2001 to 2011 & the growth is in continuous process. The population growth is more in the northern wards due to its better connectivity, infrastructure & proximity to KMC area. Real estate investment is more in this area because of affordable land value for affordable housing. The progressive shift of relative populations from rural to urban zones is known as Urbanisation. The degree of urbanisation is obtained as the percentage increase in the urban population (UNDESA, 2014). Degree of urbanization has not achieved its pace in the rural areas in southern fringes because of poor infrastructure & quality of internal rad network.

Governance Analysis: There has been a significant movement in thought during the last 20 years on how to make cities in poor nations more liveable, just, and environmentally effective. Concern about governance has replaced dissatisfaction with government. 'Good governance' is regarded as the means by which inhabitants and government institutions in any metropolitan region find consensus on how to advance towards the achievement of numerous goals and how to best achieve them. All successful projects have interdependent administrative authority with responsibilities and powers. As a result, a suitable mix of financing from various sources, such as a basket approach, combined with efficient financial management and an innovative resource recovery mechanism, would yield the highest financial return. Township would be a self-sufficient growth node built on industrial foundations and within a Master Plan that incorporates economic and physical aspects locally and regionally. Without government investment incentives in infrastructure and other facilities, the private sector cannot contribute. As a result, the government's commitment is required. Because of the lengthy process involved in development, a long gestation period has been considered. Flexible modification of plans and policies is required at the end of each phase of development. The plan's execution is dependent on the three-tier system of national, regional, and local plans that we have followed in the KMA: Vision 2025. The development of the district's Baruipur headquarters is a long-term plan based on various parameters such as social security, civic amenities such as proper water supply, garbage disposal, health services, a proper sewerage system, and so on. Infrastructure facilities such as equipped hospitals, nursing homes, international schools, and colleges, among others, are critical for the advancement of the area. Baruipur, as the most successful region for future township settlement, is attracting a large number of people, particularly middle-class people who prefer to live on the outskirts of Kolkata but have easy access to the city's core CBD. Metro services, as well as the extension of the metro up to Garia station, aided in this.

While the Baruipur area strives to maintain its top performance, there are some gaps that must be filled. As an administrative body, civic amenities must be improved, particularly the massive traffic jams at the railway gate crossing and the Padmapukur area. Spreading awareness about health to prevent diseases from entering the region, literacy to ensure better job prospects, and the role of women in society could lead to greater social stability. Proper planning and implementation of plans may alter the development scenario of the studied – region. The urbanisation process in this area clearly exhibits signs of immaturity. On the one hand, urbanisation remains primarily a Kolkata phenomenon. On the other hand, urban expansion has only recently occurred over a large portion of the district within a rural-agrarian setup. It is a typical case of ‘pseudo-urbanisation,' which is based primarily on tertiary sector growth rather than a productive and diverse economic base. However, the recent surge in the number of census towns and urban population in South 24 Parganas has highlighted the importance of paying closer attention to this type of urban settlement.

Globalisation Analysis: The local and global dynamics interact to influence changes in local institutions. The same is accurate for local and global organisations; they all have an impact on the local organisations, and it is through changes in local organisations that changes in cities and its peri-urban can begin. Due to the influence of global dynamics & global organisations the peri-urban growth of KMC area has been observed in this peripheral zone. Lot of Public & private organizations like IT, research & Educational organizations are planning for their establishments in this peri-urban district due to availability of affordable land in close proximity to Kolkata & strong connecting corridors via road network & sub-urban Railway network to different major business hubs & airport.

6.3.2 Gayespur

Growth Analysis: Peri-urban zones can be thought of as new multifunctional territories. Common characteristics include low population density, diffused settlements, a high reliance on transportation for commuting, fragmented communities, and a lack of spatial governance. (Ravetz et al., 2013). Affordable Housing deficit in this settlement areas is particularly much more severe for economically weaker sections of population. The serious deprivation in the provision of basic services to large segments of urban population is today's ground reality. This segment of urban population have less access to basic urban services, such as, land, affordable shelter, security of tenure. The housing sector in this area needs to be viewed within the perspective of the emerging macroeconomic policies for availability of affordable housing for lower & middle income group. In the political rhetoric, housing is regarded as one of the basic needs. Despite this recognition, in terms of public policies and investments, housing has generally received a very low priority. The benefits of public housing programmes have accrued disproportionately to the better-off sections of society. There is a need for bringing dynamism and enhancing the credit for housing to all the sections of the needy population specially the poor.

The development of indicators like population, density, development of housing & infrastructure, literacy are to be used as tool to define the carrying capacity in respect of each of environmental resources comprise assessing waste assimilative capacity and socio-economic capacity of the urban region to support urban population.

Governance Analysis: Analysing and regulating land use in ensuring that urbanisation supports processes of economic growth is very important. Two key policy issues in this area are the role of land and housing regulations and the conversion of rural to urban land. Efforts to manage urban growth have been an important feature of urban planning. Strategies to be included protecting farmland or open spaces in this peri-urban area. Other strategies like zoning, urban growth boundaries, green belt policies, public acquisition of land, split rate property taxes and comprehensive land use planning are required to be implemented.

The NIUA study (1995) for the National Capital Region (NCR) provides a useful example of what municipalities can do in preparing their own Local Agenda 21 by suggesting planning methods that may address issues concerning the environment in the context of available natural resources in the National Capital Region (NCR). There is a need to develop a long term strategy taking into account the limit of the available natural resources having due regard to the sectoral and environmental issues at the state and local levels with focus on delivery of basic urban services. Such management approaches and mechanisms may ensure the process of effective development.

A consolidated urban policy or guideline that simultaneously takes into consideration the challenges in the areas in this Shadow zone is clearly needed. Further densification of the older areas through residential high rises may be counterproductive as they already have high population densities. Their economic revival would be a better option. Such efforts would need to be supplemented with improved public services, such as, better solid waste management. Widening of existing corridors like NH34 & Kalyani-Barrackpore Expressway, future planning for extension of metro rail network from Barrackpore to Kalyani and strengthening of existing sewerage system is important as is the need to create housing for all income groups.

Finally, using all available non-residential land now by the development authorities, such as, developing them to provide services or as sites for new economic activities would benefit the entire region of the shadow zone along with the city core.

Globalisation Analysis: As a result of globalisation, there are also changes in governance. Once governmental structures begin to shift, macro and micro-urban changes, as well as changes in property market dynamics, are unavoidable. Changes in property market dynamics typically result in a shift in property market actors' reactions. This globalization effects in adjacent modern educational & medical hub of Kalyani & strong communication corridors with Kolktata has been observed in this municipal town. Big national educational, research & medical organizations have set up their units in & around Gayeshpur. Furthermore, the growth and development of social media channels now play an important role in people's lives because they cause significant changes in people's tastes and preferences. Regardless of the causes of globalisation, there are many ideas that believe globalisation will have a significant impact on society.

6.3.3 Pujali

Growth Analysis: According to the findings of the study, the influence zone of this peri-urban area is directly related to the socioeconomic development of this region. However, the abnormal pressure of population growth is the main constraint of this town's proximity to the KMC area. This abnormal demographic growth has caused a slew of issues, including land use, sewerage and drainage, traffic control, and proper land utilisation in this area. Budge Budge Trunk Road is the main thoroughfare in the Pujali Municipality. Many people avoid this road because of heavy traffic during the workday. During the rainy season, the majority of this municipality's areas are completely submerged.

Governance Analysis: Another issue is the lack of a master plan for the development of this area. If a master plan is developed, the problem of land use and migration influx can be properly controlled for the betterment of the residents of this municipality. The need for future development necessitates the widening of existing corridors such as the Budge Budge Trunk Road, the development of an internal paved road network, and the strengthening of the existing sewerage system. There may be multiple governance institutions within the KMA, which is expected to have increased complexities in the post-structural reform period, but the preferential alignment of fringe development has not stopped. The preference here is for real estate development, which is dependent on land availability. Governance of the urban periphery is concerned with not only multiple governance in a single region, but also with bringing out the multiplicity of the region as a whole, which is lost within the agglomeration.

Globalisation Analysis: The effects of globalisation will initially commence on a global scale then extend to the lower level. Changes which global and local aspects of globalisation recognise are from the urban systems rising to affect peri-urban areas of cities. Establishment of a massive CESC Thermal Power Station at Pujali which supports the whole Kolkata City area expanded the Horizon for this area. Recent river front development & tourism also added essence of globalization to this settlement.

6.3.4 Uluberia

Growth Analysis: Affordable Housing deficit in urban areas is particularly much more severe for economically weaker sections of population. The serious deprivation in the provision of basic services to large segments of urban population is today's ground reality. This segment of urban population have less access to basic urban services, such as, land, affordable shelter, security of tenure. The housing sector in this area needs to be viewed within the perspective of the emerging macroeconomic policies for availability of affordable housing for lower & middle income group. In the political rhetoric, housing is regarded as one of the basic needs. Despite this recognition, in terms of public policies and investments, housing has generally received a very low priority. The benefits of public housing programmes have accrued disproportionately to the better-off sections of society. There is a need for bringing dynamism and enhancing the credit for housing to all the sections of the needy population specially the poor.

The development of indicators to be used as tool to define the carrying capacity in respect of each of environmental resources comprise assessing waste assimilative capacity and socio-economic capacity of the urban region to support urban population. Such management approaches and mechanisms may ensure the process of effective development.

There exist about 70 industrial units in Uluberia Industrial Park.The Industrial Park is providing lease holding to various industrial units and institutions for setting up their plants with Building Plan approved by the WBIIDC itself. There exist two large water bodies inside the campus are breathing spaces for the zone. Some of the prominent industrial units are: 1) Ceratizit India Private Limited, 2) Saj Industries Pvt (Biskfarm), 3) Sintex Industries Ltd., 4) Goel Alloy & Steel Pvt. Ltd. Using all these available non-residential land now by the development authorities, such as, developing them to provide services or as sites for new economic activities would benefit this entire region of the shadow zone along with the city core.

Governance Analysis: Analysing and regulating land use in ensuring that urbanisation supports processes of economic growth is very important. Two key policy issues in this area are the role of land and housing regulations and the conversion of rural to urban land, improving internal road networks, sanitation, water supply management & urban amenities. Efforts to manage urban growth have been an important feature of urban planning. Strategies to be included protecting farmland or open spaces in this peri-urban area. Other strategies like zoning, urban growth boundaries, green belt policies, public acquisition of land, split rate property taxes and comprehensive land use planning are required to be implemented.

A consolidated urban policy or guideline that simultaneously takes into consideration the challenges in the areas in this Shadow zone is clearly needed. Further densification of the older areas through residential high rises may be counterproductive as they already have high population densities. Their economic revival would be a better option. Such efforts would need to be supplemented with improved public services, such as, better solid waste management. In the newer wards, the timely completion of road, rail and sewerage projects is important as is the need to create housing for all income groups. Slums and squatter settlements need to be rehabilitated and social facilities, such as schools and medical institutions, need to be created. Finally, using all available non-residential land now by the development authorities, such as, developing them to provide services or as sites for new economic activities would benefit the entire region of the shadow zone along with the city core.

Globalisation Analysis: Globalisation has a significant impact on social aspects, values, norms, and beliefs, as well as activities and processes that aid in identifying people's personalities. It should be noted in this regard that globalisation has an impact on how people live. Because of its proximity to the Howrah-Hugli industrial zone, Kolkata metropolis, and easy accessibility of transportation for various purposes the living condition of residents of Uluberia has a certain effect of Globalisation.

6.3.5 Inferences

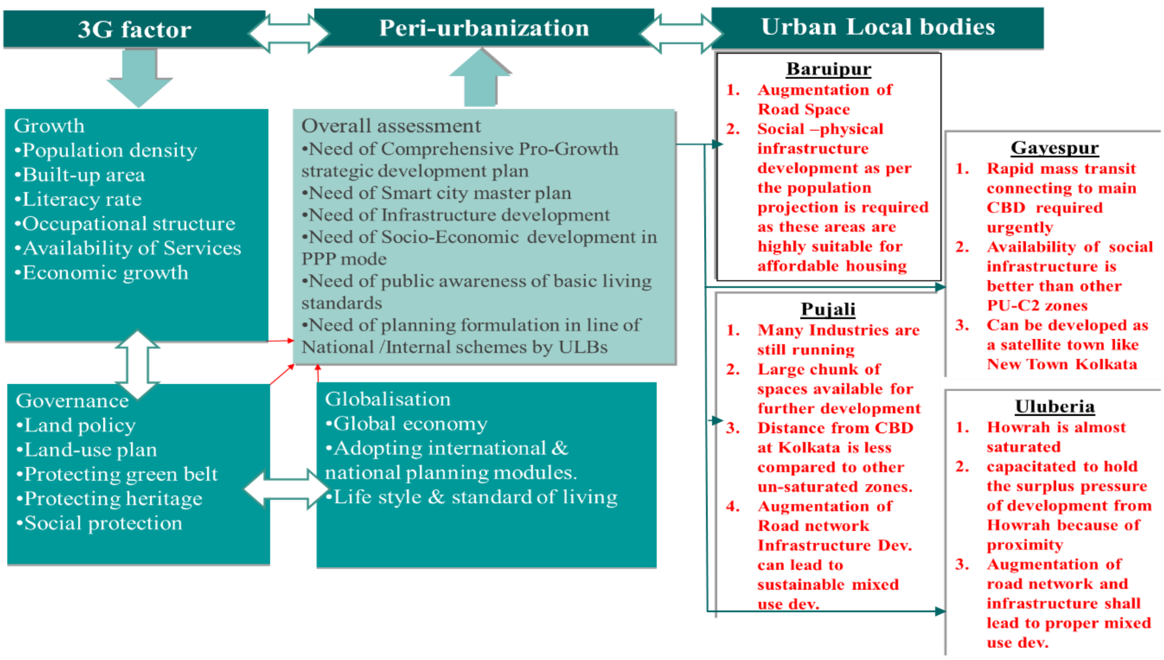


Figure 6. 44Impact factor diagram for the 3Gs (growth, Governance, Globalisation) on peri-urbanization. Source: Author.

7 Result and interpretation of objective 4

Objective V: To recommend guidelines for policy formation & new tools of intervention for efficient development of human settlement in peri-urban expansion/growth.

The basic understanding and epistemological complexities for trying to identify peri-urban spaces characterised by the transition from rural to urban economies are also evidenced. Due to the obvious burgeoning encounter between the city and the rural hinterland, these spaces emerge as a new landscape wherein urban-rural links are redefined. They are very versatile, as what is peri-urban today will indeed be urban tomorrow, posing significant challenges to decision makers and planners in controlling these spaces over their development period. However, no clear definition or standard methodology for demarcating transitional areas is available. Since some of these indicators encompass change processes, the methodology used in this research could potentially assist in determining peri-urban regions. The "scale factor" is another substantial example of this approach. Since the identification was done at the grass root level, this technique is capable of capturing micro level complexities which have not been observed in other research findings (fig. 7.1).

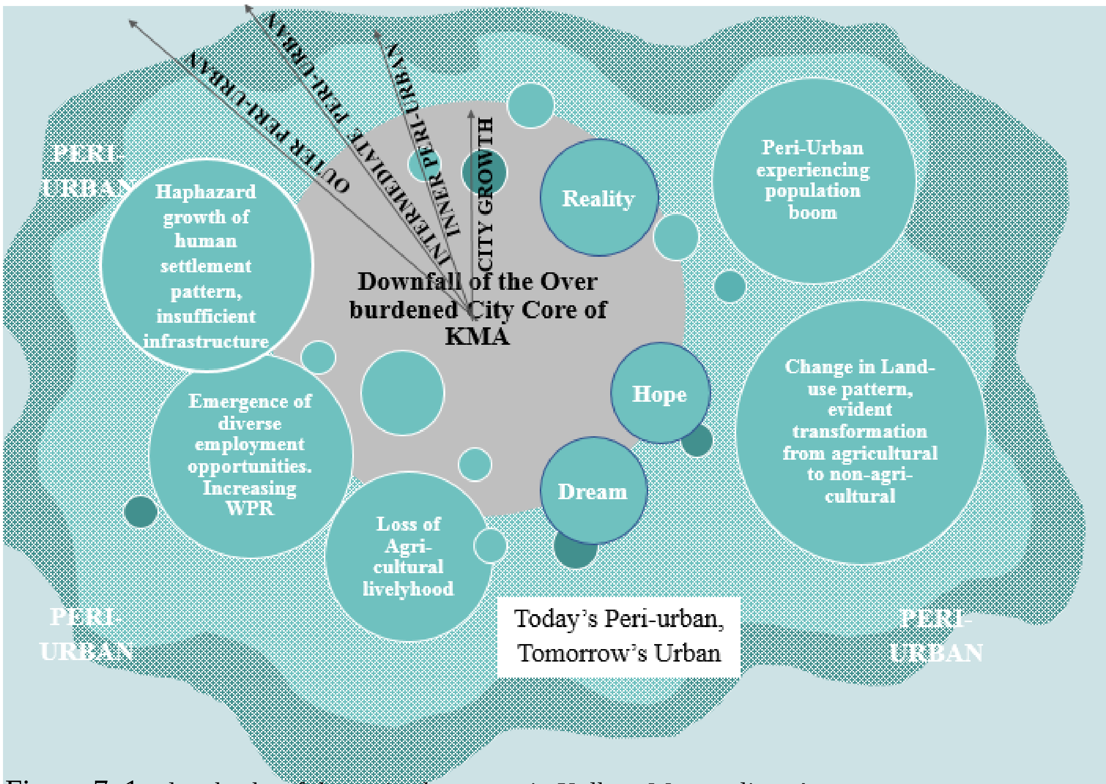


Figure 7. 1 : drawbacks of the peri-urban areas in Kolkata Metropolitan Area
Source: Prepared by author

1. With some exceptions, the peri-urban regions of Kolkata preserve this same geographical spectrum among cities and the countryside.
2. The megacity's transitional regions have been undergoing growing population, while the urban core is fairly stagnant or shrinking in relation to population upsurge.
3. Once one begins to move away from the central core, the impact of urban growth lessens; the inner peri-urban interfaces grow rapidly than that of the transitional or outward areas.
4. Land use transformation: As a consequence of fast urbanisation, the built-up area keeps increasing at an astounding rate, and far more agricultural land is being used for non-agricultural purposes.
5. Non-farm activities have increased in such interfaces as a result of decreased efflux of agricultural land and, as an outcome, decline of agricultural livelihood.
6. Modifications in demographic and land use character traits in Kolkata's peri-urban regions have an influence on the regional economy. The rising WPR and reducing exclusion of employment in transitory regions refer to the upsurge of diversified employment options in non-agricultural areas in peri-urban regions.
7. Due to the temporary nature of labour concerning men of the household, smaller household size can be traced in peri-urban areas.

As per the observations of the preceding study, peri-urban regions of urban centres are evolving as **"new economic regions,"** luring industries as well as other business ventures due to their own advantageous location, cheap land and human labour, and liberal regulations as a result of an ambiguous governing structure (Tacoli, 2003; Narain et al., 2013; Sen, John, & Priya, 2018). Even so, peri-urbanization processes are recognised by unequal advantages and threats. Although peri-urbanisation on the urban periphery fosters larger population progress and prosperity benefits by providing diverse opportunities for employment in the burgeoning non-agricultural sector, also it magnifies gender inequalities at employment. As a direct consequence, the following issues need to be resolved: Are there more disparities and shifts in employment in peri-urban areas than in urban centres and rural regions? How do peri-urbanisation processes contour disparities in city peri-urban spaces, and do new kinds of inequality and injustice emerge in peri-urban interfaces that cannot be seen in the other regions? This report also contains essential information for relevant stakeholders for preparation and implementation of their plans. In terms of addressing the complex nature of evolving peri-urban areas, preparing projects and focused initiatives to improve job prospects for workforce sub-groups are necessary, in addition to the provision of basic facilities and infrastructure.

7.1 Guideline to ULB

7.1.1 Policy Framing under GROWTH

Capacity to control urban growth have been characterised by OECD (Organisation for Economic Co-operation and Development) countries' urban planning programmes. As aspects of methods, cropland and green fields in peri-urban regions have already been secured. Urban areas are experiencing exponential growth in OECD countries, spurring the formation of restrictive measures such as growth restrictive measures and GDP growth. There also are zoning, urban sprawl limitations, green belt regulatory requirements, and publicly owned land acquisitions guidelines (OECD 2010). Area-based income generating initiatives, which also are meant to address purely regional employment development challenges and scarcities, have become more prevalent in OECD countries. Numerous OCED nations have grouping methods in place to inspire urban entrepreneurial activities. In light of the global advancement, a financial and resource survey of the country ’s economic growth and resources is required. Sectoral strategies must emphasise resilience to climate change as well as the advancement of unanimous agreement between many regional powers (OECD 2010). The built-up area in peri-urban Kolkata, like the built-up area in the other metros, has expanded dramatically and unplanned.

7.1.1.1 Land use control

Appropriate land and resource planning enables the logical and long-term use of land to suit a number of requirements, including social, economic, developmental, and environmental ones. Proper land use planning, based on sound scientific and technical procedures and land utilisation strategies, and backed up by participatory approaches, empowers people to make decisions about how to allocate and use land and its resources in a comprehensive and consistent manner, meeting current and future demands.
In order to achieve community physical, economic, and social efficiency, health, and well-being, it requires the scientific, aesthetic, and orderly disposition of land resources, facilities,

and services. To settle claims/counter-claims of these sectors, it is in need of interconnected land use planning, that also includes agricultural production, industry, business, forest areas, quarrying, residential infrastructural facilities and urban neighbourhood settlements, transport systems, and so "Land use planning" is the method of reviewing land and alternate solution patterns of land use, as well as many other physical, social, and economic conditions, with the goal of identifying and implementing those forms of land use and plan of action that really are better suited to accomplish specific goals. National, regional, state, district, hydrologic, town, village, or other local land use planning can take place.

Due to the rarity of district-level spatial land use schemes, regional development spurred by urban or industrial growth, or infrastructure construction that must be regulated due to the presence of large eco sensitive zones, necessitates initiating land use planning for such (urban, industrial, or eco sensitive) areas in order to achieve sustainability.

Unplanned and haphazard development has the potential to have negative consequences, such as land use conflicts with neighbouring land use activities, especially agricultural areas, rural uses, natural resource regions, and ecologically sensitive and delicate ecologies, as well as damage to productive land and sustainability issues, if immediate action is not taken.

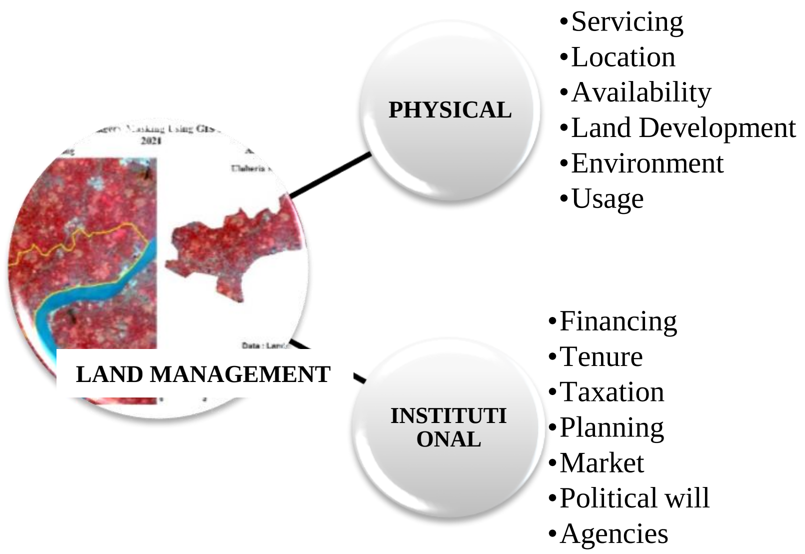


Figure 7. 2: land management and growth control –the key elements & components, in peri-urban areas of Kolkata Metropolitan Area. Source: Prepared by author

The physical features of land are principally related to planning, insecurity, land development opportunities, environmental aspects, accessibility and choice, and facilities. In the KMA area, the preparation of land - use and landcover plans, spatial planning, and master plans for peri-urban regions is crucial to curtailing exponential population sprawl, for which expert organisations should indeed perform extensive studies and assessments for the accessibility of potential development locations, and also contemporary GIS Classifier model. Conservative planning and bye-laws are required to be followed in saturated areas where land is not available, to control even farther unplanned development from an environmental standpoint. In these regions, it is essential to boost existing local services, construct multi-node routes, create basic facilities, and preserve green pastures and historic and cultural properties. (Fig. 7.3)

Provision of tenure, registration of plots and connected land registry information, funding of purchase of land and maintenance, trying to establish and trying to enforce growth controls, recognising ecological integrity of areas, and tax system are all institutional elements, and so are the democratic will and governance structures expected to undertake all these responsibilities. The physical and organizational elements of any residential development strategy (Government housing programme, Locations and Facilities, Unauthorised Establishment, Validation and Update, Public-Private Collaboration, etc.) around each other established a foundation for planning for land-development management and urban expansion (Fig. 7.3)

Land cover managing indeed is complex, entailing the assimilation of all components in order to work properly in perfect harmony. Land management, in specific, requires accumulating spatial quantities regarding susceptible land and recognising land available; safeguarding water sources, greenery, terrain, and irrigation courses; directing land development via processes (land consolidation, land wealth management, etc.) and incentives; locating accessible lots near socioeconomic opportunities; and enabling land maintenance (access, water, sanitation, power, solid waste management). Moreover, institutional allowing forms of ownership (government, private, communal) and security (freehold, leasehold); surveying and registration; planning growth needs and expansion; defining instruments and incentives (FAR, etc.) to engage individuals and private developers; and considering the supply-demand dynamics (speculation and mechanisms to address it: punitive taxation, development controls, etc.; land acquisition).

7.1.1.2 Inclusive TOD planning

Transport Oriented Development, Urban Planning & Land Management:

TOD (Transit-Oriented Development) is very well-known method for assimilating land use and transportation for protracted urban development. TOD discussion generally affirms its pledge of generating large, compact, and blended developments supported by public transportation to reduce its dependence on personal vehicles and thus sprawl, overcrowding, and carbon emissions. Several researchers, on either hand, alerted that the exclusion of creating opportunities would transition TODs into Transportation Adjacent Developments (TADs), substantially straying from of the goal of urban sustainability. India, like many other developing countries, is attempting to deal with several urban transportation issues, including increased use of private vehicles, traffic congestion, deterioration of the urban environment, unfairness in the allocation of road space among cars and pedestrians, an increase in road accidents, and so on.

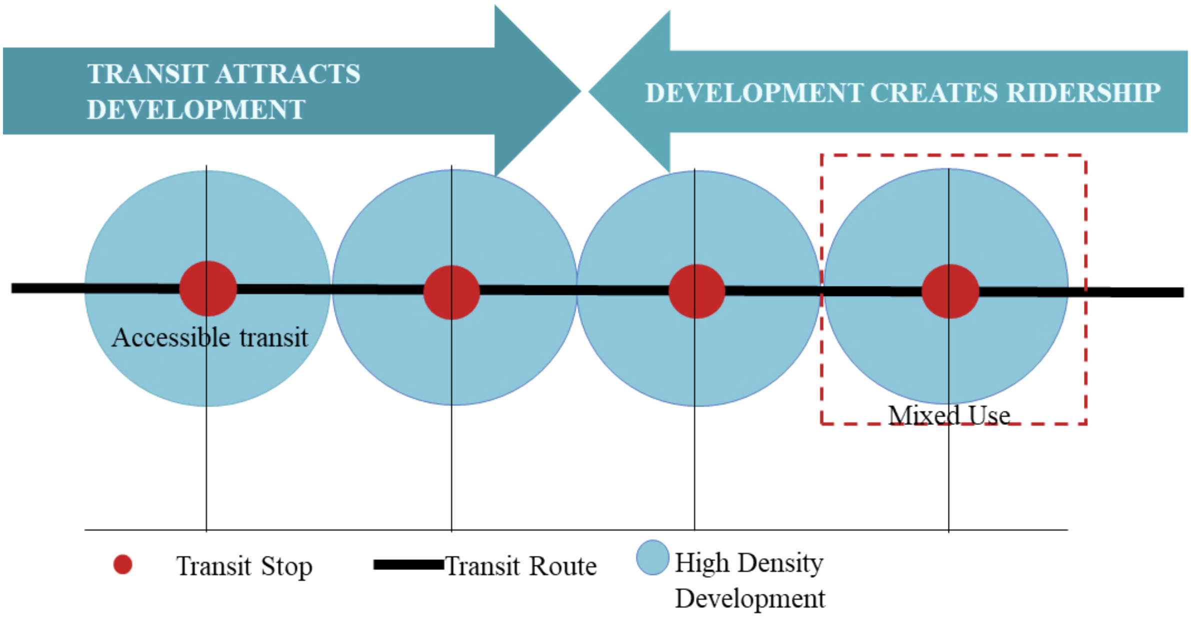
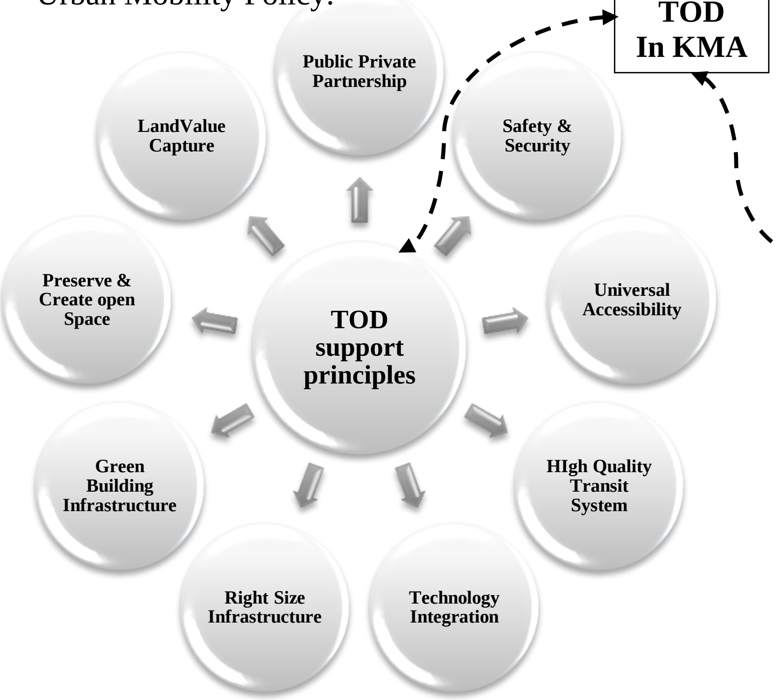


Figure 7. 3:Transit Oriented Development- need in Peri-Urban areas of Kolkata Metropolitan Area.
Source: Prepared by author

The Indian government needs to rely on TOD to identify existing urban transport problems and, as a consequence, locations a high price on mass transit systems in order to reach the aims of ‘growth of urban transport along a low-carbon path.' This has in recent times resulted in the creation of Rapid Transit Systems (RTS) in a majority of Indian urban centers, and relevant agencies are working on developing appropriate TOD regulations. Although some of those cities strive to concentrate on the TOD prospects availed by latest RTS investment opportunities, there are many discussions in India about just how TOD must be executed. Many of these conversations centre on the initiatives and possibilities for land development along transportation routes. Other issues and challenges related to functional connectivity of land use and transit, sustainability, equity, and implementations are, unfortunately, less discussed. The purpose of this article is to identify issues and challenges for TOD in the context of a developing scenario—in this case, the Kolkata Metropolitan Area (KMA) in India. The issues are identified, and the need for a multidisciplinary approach to developing context-specific and carrying-capacity-based TOD strategies that allow development along the "low-carbon path" is suggested. Keywords for “Transit-Oriented Development**”**

“i)Transit adjacent development, ii) TOD, iii) TAD iv) Smart development v) Low-carbon development, vi) Land use-transportation”

TOD concentrates on compressed mixed-use development near transit corridors such as metro rail, BRTS, and others. International cases illustrate that, whilst also public transport systems facilitate transit-oriented development, working to improve ease of access and creating walkable neighbourhoods are crucially significant. This TOD policy (fIg.7.8) describes 12 Policy Guidelines and 9 Endorses in relation to the objectives of the National Urban Mobility Policy.



TOD COMPONENTS: TOD Support Principles tools

- **COMPLETE STREETS**
- **LAST MILE CONNECTIVITY**
- **INCLUSIVE HABITATS**
- **OPTIMISED DENSITIES**
- **MIXED LAND-USE**
- **INTER CONNECTED STREET NETWORK**
- **TRAFFIC NETWORK**
- **TRAFFIC CALMING**
- **MANAGE PARKING**
- **FORMAL SECTOR INTEGRATION**
- **STREET ORIENTED BUILDING**

Figure 7. 4: Transit Oriented Development elements
Source: Prepared by author

New urbanism, smart growth and TOD: In response to the challenges of urban expansion caused by automotive vehicle reliance, Urban Regeneration and Smart Economic expansion have emerged in India over the last four decades. They are deeply embedded in a quest to seek alternatives to low-density, single-use, and spread-out patterns of urbanization process, that also significantly raise traffic congestion and pollution whilst also negatively affecting the environment and quality of life.

Urban Regeneration is a design-oriented movement which has architectural foundations. It is promoted by architects and concentrates on neighbourhood design. Smart Growth is a policy-driven initiative with environmental roots. It is mainly focused on helping to promote steered development and therefore is initiated by planners. New Urbanism is more concerned with growth promotion than with urban development. It needs to shift the discussion about urban planning away from growth control and toward how and where growth should be accommodated. It advocates for public growth subsidies such as infrastructure and land use incentives. TOD is advocated by both New Urbanism and Smart Growth.

Transit Oriented Development (TOD) owes its origin to the paradigms of New Urbanism and Smart Growth. It is an urban planning and development approach aimed at creating vibrant, liveable and sustainable communities by concentrating growth around one or more transit stations or within a transit corridor. It emphasizes compact, walk-able, mixed-use communities with access to high quality transit services within a walking distance.

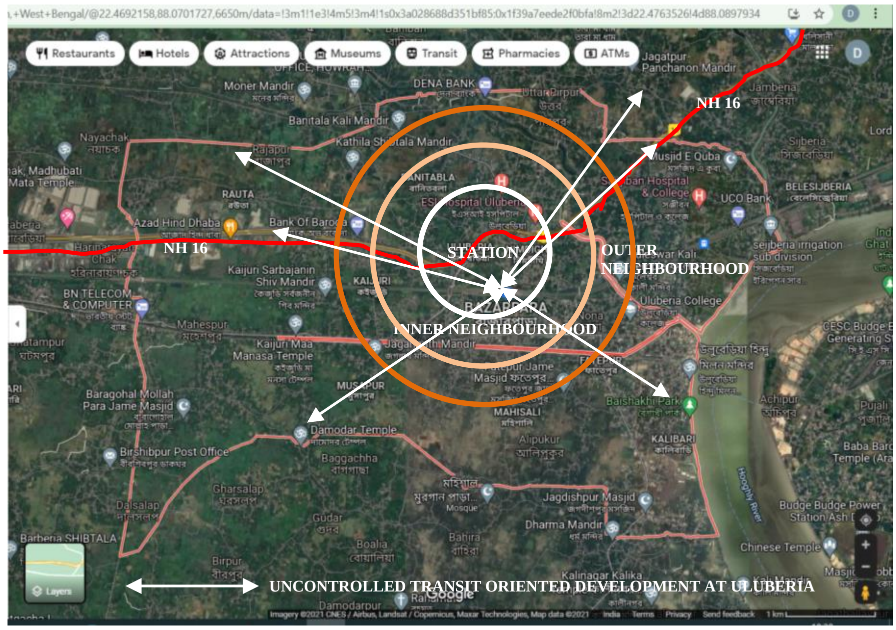


Figure 7. 5: Transit Oriented Development at Uluberia, Howrah
Source: Prepared by author

The composition of growth based on a TOD strategy aims to tackle urban sprawl as well as the economically unviable outgrowth of costly infrastructure, catalysing external economies of conglomeration, alleviates heavy traffic inefficiencies, as well as aids in resource mobilisation via rises in property and land value systems and other tax bases. TOD empowers for stress-free lifestyle without relying exclusively on a vehicle for transportation. This is both eco-friendly and comprehensive. Once poor folks who doesn't own vehicles are also included in a TOD system, those who benefit enormously. TOD, as an indicator of inclusionary regional and urban planning, aims at promoting the integration of the underprivileged in the context of the urban development.

TOD-Social Advantages: Accessibility of residences and commercial public transit seem to be vital instruments of social integration. They enhance access to employment, universal healthcare, youth development, entertainment, and social activities.

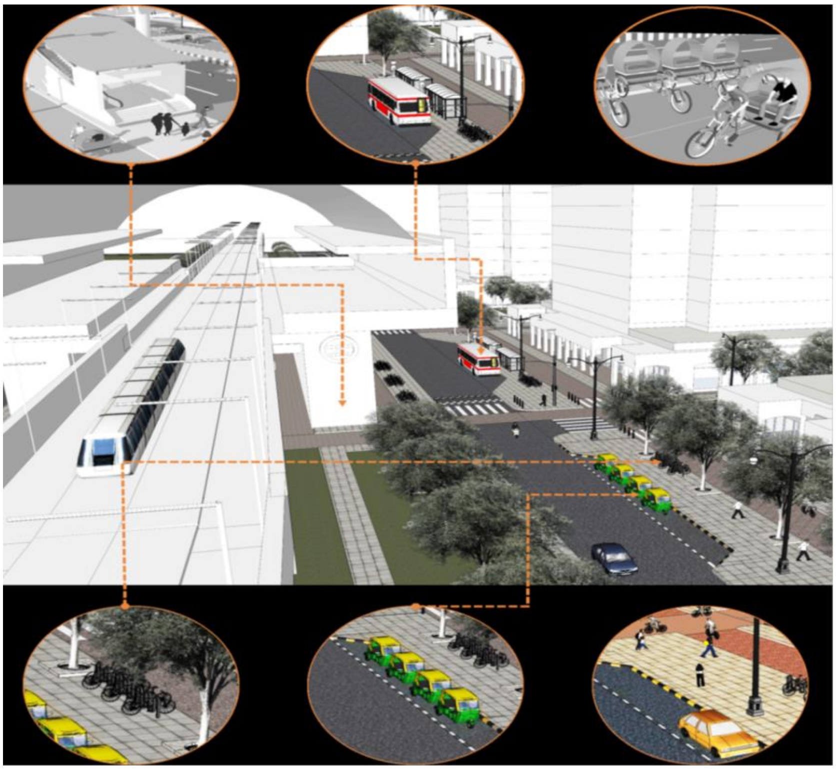
TOD-Environmental Profits: Public transport system can help decrease the number of individual cars on the road hence the scale of carbon output. This decrease could be substantial, particularly during peak hours.

7.1.1.3Mass rapid transit development

Transit-oriented development: design principles-Multimodal Transit Station.

TOD focuses on transportation. Transportation amenities must not be designed in exclusion, but instead to relate communities and peri-urban regions. Moreover, it should also include a variety of modes including such as two-wheelers, cars, bicycles, as well as public transit systems such as Auto, rikshaw, bus, and metro service (fig. 7.10).

Metro Accesses High Frequency Feeder Bus Service Cycle/Rickshaw Stand



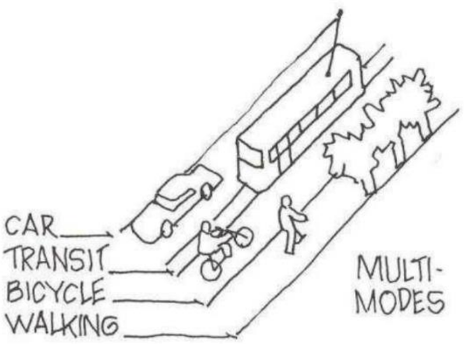
Safe Bicycle Parking Para transit Parking Private Drop-off/ Pick-up

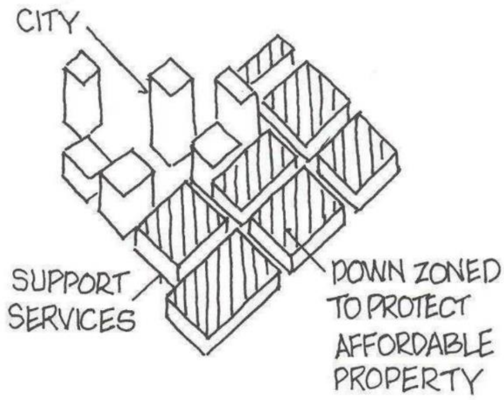
Figure 7. 6: Transit Oriented Development guidelines in the peri-urban areas of KMA
Source: Smartnet.niua.org

i) *Linked Roads:* This trend not only reduced traffic but also inspires mixed-use development and much more transportation options.

ii) *Walkability:* It really is vital to develop a commuter-friendly framework in order to promote walking. Pavements, darker pedestrian walkways, reclining benches, and safe road crossings at transport hubs must all be included in such a framework.

iii) *Compact Growth:* For a framework to be effective, it must be consolidated. This same size of outlying neighbourhoods' transportation hubs is ascertained by a comfortable easy reach from periphery to core (approximately 400 to 800 metres in radius).





Multi-Modes Corridor Compact Development with Urban Diversity
Figure 7. 7: Urban Planning and Land management for peri-urban areas
Source: Asian Development Bank. Adb.org

iv) Road Building structures: By locating buildings near streets, they can be properly defined. To personify the structure wall and stimulate the walkways, street front shopping should be made available.

v) Metropolitan Place-making: A viable TOD design focuses on building urban realm in the nearby region. It is crucial for improving social contact along with building community ties and involvement.

vi) Neighbourhood Main Street: Shopping sidewalks provide routine products and services, stimulate the road, decrease auto dependence, and boost pedestrian equity and security.

vii) Street network Layout: A well-designed street structure with pedestrian facilities serves as a motivation to wander as well as tends to make it much more pleasurable whilst also narrowing the perspective of distance.

viii) Bicycle-Friendly Road / Parking: Bicycles are a much more efficient and environmentally friendly form of transportation than automobiles. Bicycle lanes, biking paths, and safe carpark start making cycling a sensible alternative.

ix) Urban Parks and Public squares and promenade with a Low Ecological Footprint: Green spaces actively promote interconnected and stronger communities.

x) A Well-designed Transportation Terminal for an Elevated Customer Experience: A successful TOD framework is made round a well-designed transportation hub.

Its configuration is crucial for improving consumer interest and making sure streamlined and secure customer adaptability.

xi) *Lesser Parking Standards: Lowering parking standards frees up more site space for alternative public amenities.*

xii) *Safety and Security: Guaranteeing the protection and reliability of transit passengers, particularly pedestrians, not only enhances the public transportation experience but also increases passenger demand.*

xiii) *Market Recognition and Effective Execution: A thriving and transportation system-friendly environment that tends to attract a range of positions and inhabitants is critical for a TOD programme. A impactful TOD can be guaranteed by adaptable strategies as well as design features which satisfy the requirements of the surrounding region.*

7.1.1.4 Planning of core city /urban area

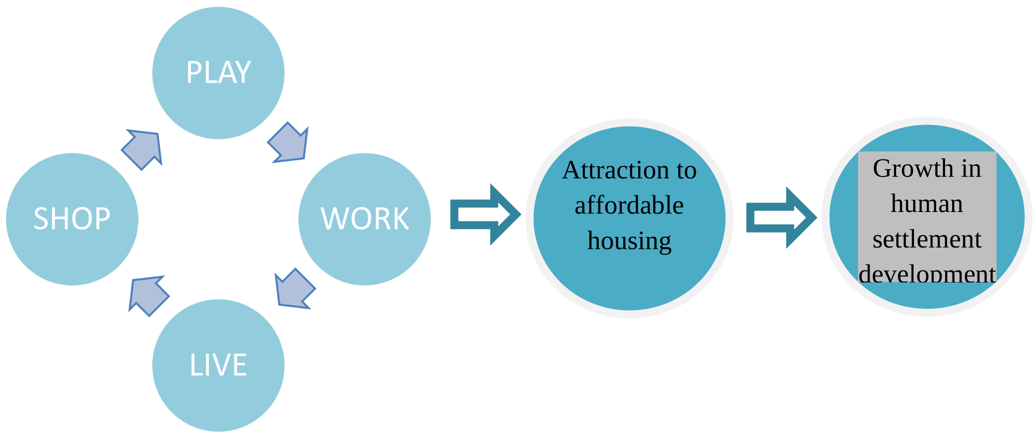


Figure 7. 8 : human action pattern – generating built-up forms in peri-urban areas of Kolkata Metropolitan Area
Source: Prepared by author

Key Principles of matrix for implementing sustainable human settlements in Peri-urban communities include:

- Integrated Transport System
- Mix of Complementary Land Uses
- Food Availability & Affordability
- Resilient Urban Design
- Inclusive and Active Community (Participation)
- Global Economic Initiative (“think globally, act locally”)

7.1.1.5 Demand and supply calculation

After demarcation of an area as PU-C1 and PU-C2 following steps are to be followed for preparation of a comprehensive master plan (i) population projection for 25 -50 years, (ii) housing demand calculation for 25-50 years, (iii) traffic volume generation calculation.

These are the basic necessities to avoid any chaotic growth formation along narrow transportation corridor, loopholes like multimodal interchangeable unplanned growths, also as any major surgical intervention fails to enhance the efficiency of such nodes or growths.

7.1.1.6 State Land Utilization Policy Development: The State Government needs to develop the State Land Utilization Policy (SLUP) while preserving the National Land Utilization Policy in consciousness and combining state-specific demands.

7.1.2 Policy framing under *GOVERNANCE*

According to Satherthwaite (2008), urbanisation has exacerbated a lack of infrastructure and disaster management, along with planning for and organising disaster response. He asserts that in most cases, the key to adaptation is proficient, competent, and responsible municipal governments that understand how to implement adaptation strategies and practices into the large percentage of their work and divisions. Many necessary measures may have seemed to be slight variations to existing methods – for example, making adjustments to building codes, land subdivision regulatory requirements, land use planning, and infrastructure standards – but the sum of all minor changes with time can build greater resilience without exorbitant costs.

Land-zoning policies are important in this area since they can reduce the speed and distance required for urban travel, thereby cutting carbon footprint and helping energy conservation. Those that can also aid in order to prepare for severe weather events. Building policies can aid in enhancing energy efficiency, while waste policies can help lessen CO2 emissions. Urban authorities may be able to provide more technological and scientific innovation than national authorities alone (OECD 2010).

Accepting and learning from past and anticipating inequities and lacunae should be the policy's goal. According to Kolkata's Land Use Regulations, reformed agricultural techniques could be implemented using traditional knowledge from the city's neo population. Workplaces within bike distance may receive incentives, as could gender parity. In addition, this will be in line with safety measures for unforeseen pandemic situation like Covid-19

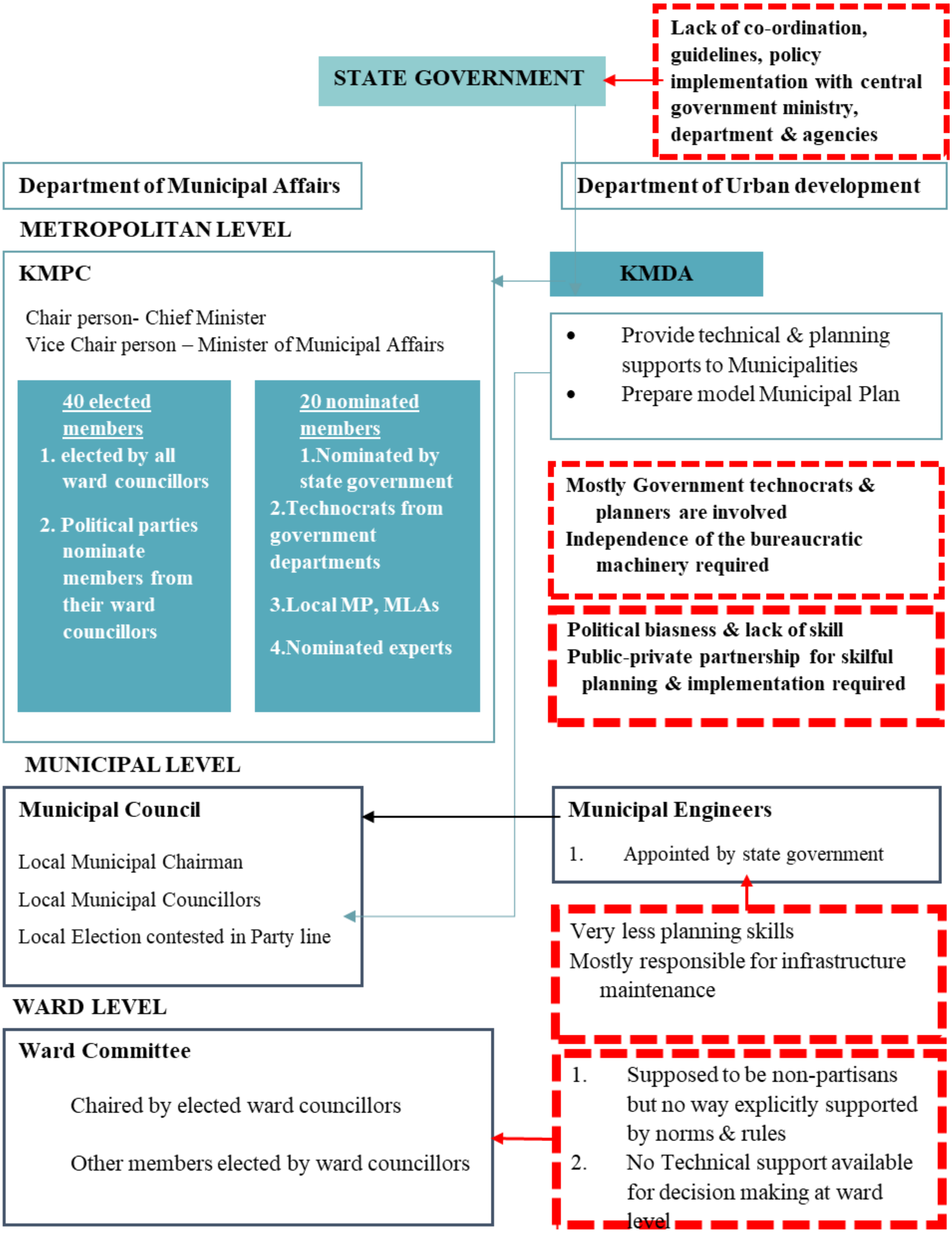


Figure 7. 9: Intervention required in existing institutional framework for policy making, planning & implementation decentralization for KMA. Source: Prepared by author

Due to the obvious indifference of the general city populace, major parties have very little motivation to decentralise planning. Bottom-up planning is incompatible with any political framework, regardless of who is in power.

This misalignment exists between the rigorous top-down hierarchy in which major parties are structured and the bottom-up strategies conceived by the amendments to the constitution. Distinction among types of affiliations may lead in a much more effective evaluation of their influence on democracy. Most ward councillors have political aspirations that broaden further than ward or municipal world affairs. To recognise these aspirations, they should at the very least limit antagonising their party leaders at the state and local level (if not actively looking for benefits from them). Even council members and municipal chairmen who chose to stay involved mostly in political matters require the cooperation of their party elites at the state and local level in order to guarantee a party ticket to run over the next council election. As a consequence, the control dynamic between both the state and the local mimics that of a benefactor-beneficiary relationship. A correlation such as this weakens the state government's attempts to accomplish democratic decentralisation in urban development. Such clientelistic relations are not limited to the loop of elected local officials.

They as well pertain to the Kolkata Metropolitan Areas' authorities' functionaries, including their planners. In discussions with few planning officials in Kolkata and a few scholars who have turned to providing guidance the state government on issues pertaining to decentralised governance, urban planning, and general populace decision - making process, there it seems to be a similar sense of consent (and, in some instances, overwhelming support for) the government with in state and that in many municipal governments in the KMA. Some, however, had also conveyed concern about the lack of freedom of West Bengal's bureaucratic mercenaries from the effect of predominant political parties. When we dig a bit deeper into the reasons of maintaining development planning collapse in metropolitan planning, we discover clues of political disunity (Fig.7.4). Fieldworkers tend to believe that the institution is did lead by politicians, government executive officers, and foreign-educated upper-middle-class plutocrats. There are non-partisan, non-governmental organisations in Kolkata that operate on urban development planning, but their existence in this structural system is negligible. Only government ministers, councillors, MLAs, MPs, and technocrats from government departments participate at the metropolitan level, where planning and economic policy decisions are made with political bias and a lack of skill. At this level, public participation with planning skills, NGOs, and representation from central government planning agencies are required.

There are very few planning skills and support from the metropolitan level available at the municipal level for the preparation and implementation of successful planning models. They are primarily responsible for the upkeep of existing infrastructure within the constraints of limited budgets. Technical assistance is available at the ward level for decision making and implementation.

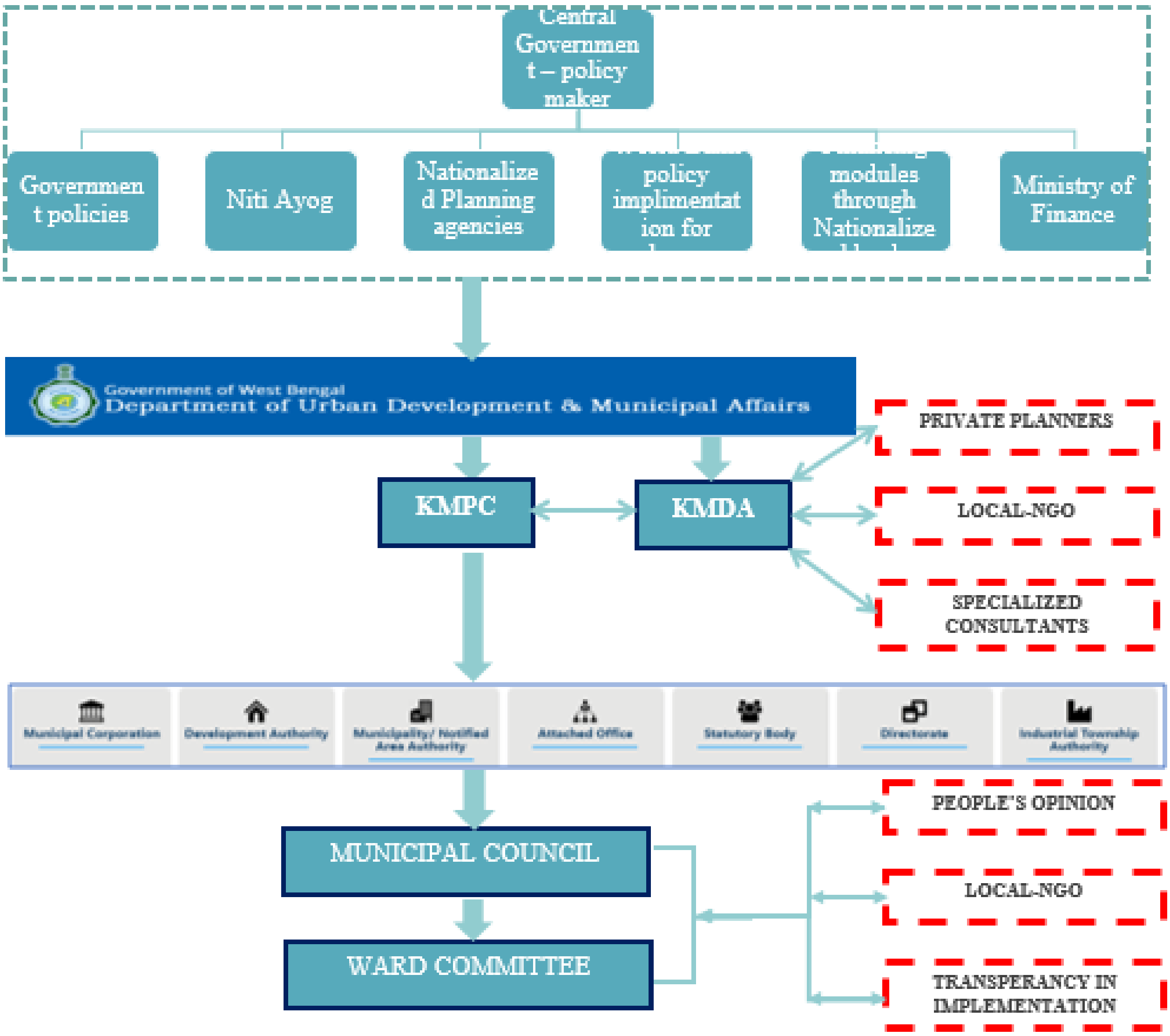


Figure 7. 10: Proposal of Good Governance in Kolkata Metropolitan Area.
Source: Prepared by author

7.1.2.1 Impacts from improper land use due to lack of governance:

"Conflicting land use practices" are those which contend with the current land use. Definite land uses have such an impact on other surrounding land uses. Agricultural production in forest areas, mining in forest areas, expressways in environmentally-sensitive areas, contaminating sectors of the economy in agrarian or eco-sensitive areas, urban/industrial development on farm land, agriculture infringing into natural forests, and metropolitan waste disposal in peri-urban regions are instances of incompatible land uses. The fundamental issue is the detrimental effect that such land uses possess on these other land use pattern. For instance, an industrial district might have had a repercussion on surrounding communities caused by air pollution, or urban sprawl may threaten the survival of the ecological system of natural drainage, thereby affecting original lagoons as well as waterways. Haphazard land use variations in eco-sensitive zones can have a direct effect on wildlife habitat, negatively impacting both domestic and international biodiversity. Competing and conflicting types of land are regularly the cause of social dispute between both the local inhabitants, officials, and market participants.

7.1.2.2 Strategy framework system is necessary for optimised land resource utilisation and role of governance:

Global warming is causing warming of the planet and also dry spells and inundating. Changes in land use, including such transformation of natural forests to agriculture or manufacturing use, can contribute to higher CO2 (carbon dioxide) (a predominant greenhouse gas) earth's atmosphere concentration levels, affecting the environment.

Pollution and disasters are on the rise as cities and industries expand, as well as the use of chemicals in agriculture. There are potential consequences from the handling, storage, and transportation of hazardous chemicals/materials and wastes, the emission of pollutants, including toxic emissions, the discharge of effluents, particularly those that are not easily biodegradable and toxic, the pollution of ground water, streams, rivers, lakes, oceans, or other bodies of water, the risks of industrial disasters, and the risks of natural disasters.

There are also growing threats to biodiversity, such as species extinction and threats to ecosystem services. There is a need for a national policy framework that incorporates the concerns of various sectors and stakeholders in order to ensure optimal land resource utilisation through appropriate land use planning and management.

Such a policy should serve as a framework for states to adopt and formulate their own policies that address their specific concerns. States should develop land use policies after consulting with all stakeholders and ensuring adequate legal support. In order to achieve sustainable development, detailed land use strategies and plans should be developed in accordance with these policies.

7.1.2.3 Meeting the demands of urbanisation by the governance:

Kolkata has traditionally been located along the major river Ganga, surrounded by agriculturally productive land and environmentally sensitive areas. Due to abnormally high land prices in cities in comparison to average citizens' household income, Kolkata is mostly spilling over to rural-agricultural belt (peri-urban areas). The peri-urban areas or fringes of such agglomerations are rapidly changing, resulting in the haphazard growth of slums, unauthorised colonies, piecemeal commercial development, intermixes of conforming and non-conforming land uses, and insufficient infrastructures, services, and facilities.

Urban areas are emerging as domestic and international investment hubs, where the majority of commercial activity takes place. As the economy grows, towns and cities grow in size and volume, and the urban sector's contribution to the national economy grows. In the coming years, the urban sector will be critical to the structural transformation of the Indian economy and the maintenance of high rates of economic growth. Ensuring high-quality public services for all in cities and towns will also help India realise its full economic potential.

7.1.2.4 Meeting the demands of industrialization & governance:

Industrial estates, special economic zones, specialised industrial parks, investment zones, NMIZs, special investment regions, PCPIRs (petroleum, chemicals, and petrochemical investment regions), and industrial corridors take up a lot of space. Industrial development is linked to supportive development, such as housing areas, transportation, trade and commerce areas, wasteland, waste water treatment and disposal areas, and so on, all of which require significant amounts of land. In comparison to Northern and Western India, Kolkata has experienced very slow industrialization growth. The establishment of a large number of SEZs under the Special Economic Zone Act of 2005, involving a large area of fertile agricultural land, has exacerbated India's already strained land relations. An SEZ may have far-reaching effects on the local economy. People, on the other hand, lose access to farmlands, grazing grounds, bodies of water, and other common resources. Agrarian protests against SEZs are common throughout India.

7.1.2.5 Development vs. sustainable development-under governance:

Development activities necessitate land, and they have the potential to displace people, exploit natural resources, have negative environmental consequences, and cause other land use conflicts.

There is a need to assist various sectors in achieving their development goals, such as urban development, industrial development, mining, and infrastructure development (transportation, ports, harbours, airports, and so on), through properly guided development that is sustainable and harmonised in order to avoid land use conflicts or negative impacts.

7.1.2.6 Protecting social interests by the governance:

West Bengal has a significant number of vulnerable populations in rural, tribal, and backward areas, many of whom lack adequate access to basic amenities and proper livelihood. There are disadvantaged and vulnerable communities, such as tribal populations, economically disadvantaged groups, and backward communities. There are concerns about livelihood, poverty alleviation, inclusiveness, and gender. There is a need to support social development initiatives that address these issues. Land is crucial in all of these situations. There is a need to prevent or at least minimise social conflicts arising from the acquisition of lands or the development of such conflict-inducing activities. Land use planning should be carried out with due regard for social aspects.

7.1.2.7 Heritage preservation-the role of governance:

India has a rich cultural and historical heritage. There are a number of scenic beauty and tourism areas. All of these areas, including religious sites, scenic areas, heritage areas, archaeological sites, and so on, must be protected from the detrimental consequences of development and land use changes. There may be potential consequences depending on the development activities that take place in the vicinity of these areas. Such impacts could be avoided and heritage areas protected with proper land use planning and management.

7.1.2.8 Inadequate land use planning capacities:

In the country, there is a severe lack of a systematic, orderly, and up-to-date spatial data base that is readily available for land use planning purposes. In addition, due to the lack of a systematic database, making projections and forecasting of prospective needs for land uses by various sectors would be difficult at first. However, the country is quite advanced in the use of Geographic Information Systems (GIS) and remote sensing, which are useful for creating spatial databases. The Indian government is already working on establishing a National Spatial Data Infrastructure. Such spatial databases could be built up in a systematic manner over time.

Furthermore, the state's current land use database is woefully inadequate. There is no mechanism in place to track land use changes and their consequences. The implementation of systematic and integrated land use planning at the state and regional levels will be a major challenge. There must be supportive tools (mapping, spatial information, planning processes, tools, methods, procedures, standards, and so on) for land use planning and management that take into account inclusiveness, poverty, gender, and climate change.

A further consideration is the availability of guidelines for consistent land use planning. Except for the urban sector, where guidelines for urban development plan formulation and implementation (UDRPFI) exist, other sectors such as industry, environment, transportation, mining, agriculture, and so on lack similar guidelines. To ensure proper land use planning, detailed guidelines for following integrated approaches catering to all sectors are required.

Also there is a lack of adequate institutional structures at the state, regional/district, and local levels for land resource planning and management. The only way to control urban sprawl in peri-urban/fringe areas is to obtain land availability documents for those areas. Saturated nodes will be subjected to conservative planning and decentralisation strategies. Land-use control plans for much less concentrated prospective peri-urban nodes must be prepared.

1) Long-term planning for optimum land use and conservation of scarce land resources is essential, and projects should be set up on recycled lands, wastelands, degraded lands, or un-irrigated lands whenever possible, provided they are not performing any other important function such as bio-diversity, water resources, and so on.
2) Urban regeneration planning must be comprehensive, long-term, and vertically integrated (national, state, regional, and local levels), taking into account the interests of all other sectors and stakeholders.
3) Land-Use Development planning is an exercise that stipulates the use of land for rural, urban, and industrial growth as well as environmental conservation in terms of improving a community's physical, financial, and cultural performance, performance, and well-being.
4) Land use planning should be undertaken independently or, where possible, integrated into Regional Plans, District Development Plans (covering both rural and urban areas), Master Plans of Cities, Zonal Development Plans of Eco Sensitive Zones, or Development Plans of Industrial Investment Regions for all Land Utilisation Zones.
5) The National Land Utilisation Legislation states a strategy for implementation that takes into account the fact that “land and its management” is a State subject.

7.1.3 Policy framing under *GLOBALISATION*

Since the early 1990s, the rise of neo - liberal India, its globalised market economy, and aggressive increase has contributed in a boom in the development, expansion, and economic advancement of its metropolitan cities. These cities are growing into metropolises, with iconic, majestic new buildings, glimmering shopping centres, and immaculate and heavily guarded housing isolated communities to shelter the rapidly growing professional classes and start-up ventures. The significance of these Indian worldwide metropolises throughout terms of its role and position in the inter - connectedness of neo - liberal global capitalism, manufacturing, and utilisation cannot be exaggerated. Undoubtedly, it also is asserted that research papers of the world class city have continue to encompass our understanding of contemporary urbanism in the 21st century, ignoring the impact of peri-urban small towns in such procedures. There is a greater need to capitalise on globalisation, particularly in terms of people, products, ideas, culture, and capital, to positively design and develop cities that will improve people's standard of living and quality of life. Domestic or local planning authorities and architects are strongly encouraged to adopt international standards in order to produce developments and designs of international standard and quality. Urban areas or urban administrators should oversee public resources well enough in sequence to be pledged with vast amounts of international capital. Good city management is required to accomplish improved use of funding provided to urban planning & development. Various types of particles neighbourhoods in the KMA area have different requirements, obstacles, and possibilities. Comfortability of those is quite often crucial not just to their residents, but also with the economically and socially togetherness of metropolitan areas and profound rural regions. Even so, they are largely neglected in government legislation, falling through the crack formation among both urban practices and regulations for underprivileged rural areas. Again, for past 20 years or so, there has been a comparative dearth of research into small towns, with researchers focused on the impact of globalisation and technological change on large cities and urban regions. It is aimed to discuss a few of the significant research themes which have occurred in recent centuries. This has been ascertained that there is an immediate necessity to broaden our comprehension of the specific role and peri-urban municipal towns of KMA in the context of current India's economy, society, and political entity.

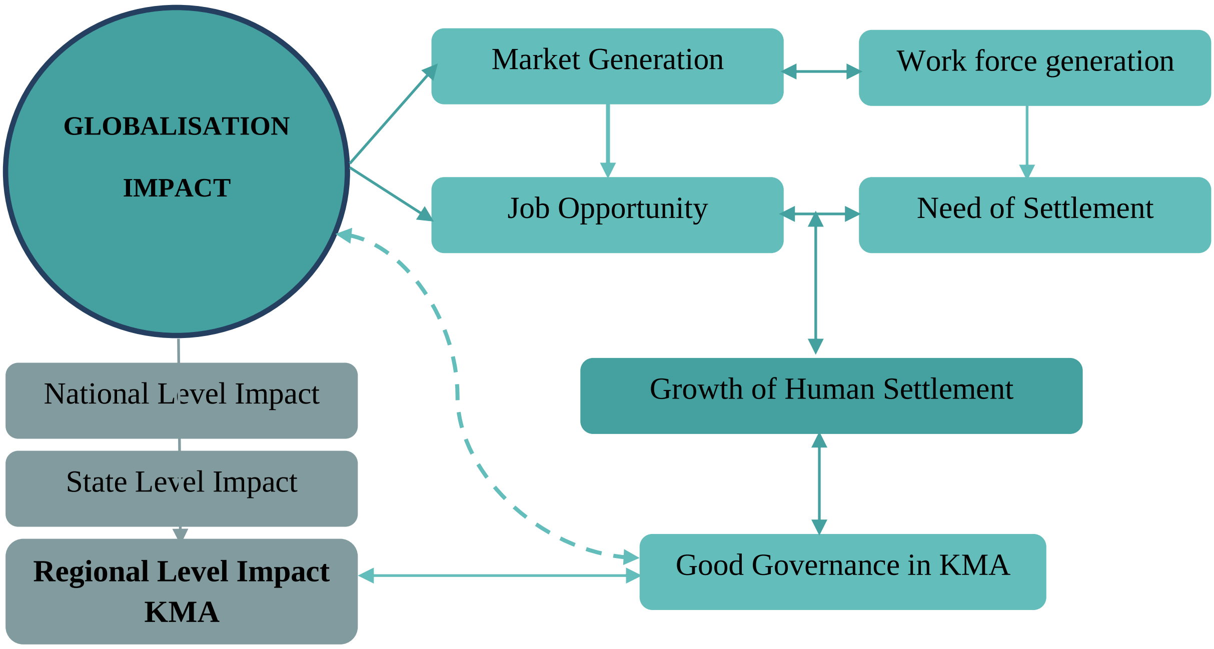


Figure 7. 11 : Proposal for mitigating Globalisation Impact in Kolkata Metropolitan Area.
Source: Prepared by author

7.1.3.1 Land Policy:

Recent studies have reported the increasing importance of trying to analyse and attempting to control land use in order to make sure that rapid urbanisation endorses economic expansion processes (Clarke Annez & Linn 2010, OECD 2010). Housing and land constraints, and also the exchange of villages to cities estate, have a massive effect here (Bertaud 2010). Land tenure agreements in so many rapid urbanisation processes in emerging countries had also struggled to keep pace with population increase (Simler & Dudwick 2010). Many cities' 'peri-urban' are disputed by a variety of authorities (Simler & Dudwick 2010).

Unplanned growth and rapid urbanisation had also contributed in market distortions in so many OECD (Organisation for Economic Cooperation and Development) nations, triggering the progress of land use regulations and land-related policy proposals (OECD 2010). The large percentage of OECD countries perform thorough survey data on urban land usage. Value of the land survey results have become more prevalent as urban infrastructure planning and municipal property tax systems are becoming more advanced (OECD 2010). According to United Nations Habitat (2011), the issue of land markets is particularly important in

Africa's urbanisation. The majority of land transactions in Africa take place in informal marketplaces. Because public lands are overburdened, official markets should adopt informal market methods. Governments, for example, should rationalise fees, improve registration procedures, and phase out the burdensome dual legal and procedural system in the urban real estate market (UN-Habitat 2011). These audits are a valuable tool for improving land use and regulatory compliance. High-quality data, as well as strong governance and financial resources, will be required for these to function (Bertaud 2010).
Land ownership restrictions in Kolkata's inner city, in our opinion, will not be able to halt the natural process of conversion. In this case, the government's acquisition of land in peri-urban areas long before actual growth processes in the city's periphery must be considered. It was only through the implementation of controls that it was possible to ensure the density and quality of built-up area.

7.1.3.2 Inequality and Social Exclusion:

Despite the fact that poverty rates and service delivery performance are generally higher in cities, rapid urbanisation has exacerbated inequity in both urban and rural areas (Simler & Dudwick 2010, SH comments). Numerous studies show that there is an increasing need to expand the delivery of public services to all segments of society – both inside and outside of urban development hotspots. Clarke et al. (2010) contend that comprehensive service provision is required to mitigate the impact of expanding urban slums, worker migration, and rapidly increasing social unrest. As a result of free market attitudes toward rapid urbanisation, social stratification and exclusion have become more prevalent in cities. According to a recent UN-Habitat (2011) report, building benchmarks should be set more pragmatically to reflect a country's administrative capacity. The emergence of urban major thoroughfares and urban areas creates new, highly complex geographic, governmental, and political situations. To address the regulatory frameworks in these areas, comprehensive regional planning and urban governance are required.

Kolkata has also demonstrated exclusion and inequality in land acquisition and distribution processes, and it must learn from its mistakes in the future. Involving legitimate landowners in peri-urban areas for guided development while preserving distinctive character appears to be both necessary and feasible. Women's inclusion has resulted in the successful realisation of intended outcomes in rural and semi-rural areas, according to financial models (Grameen Bank of Bangladesh and Bandhan Bank of India). This model has also been successful in the settlement of inner-city slums.

7.1.3.3 Regional approach:

The OECD countries are increasingly recognising the importance of connecting urban and rural communities (OECD 2010). One of the most important emerging issues in recent research is the rise of "city-regions" or urban agglomerations, which raise new governance concerns. Planning and development strategies are being re-evaluated in light of the growing recognition that urban and regional development are inextricably linked, necessitating new forms of urban-regional governance (Clarke et al 2010,). Clarke et al. (2010) argue in a conference report that organising cross-border cooperation around a shared agenda to manage intraregional infrastructure needs, such as energy distribution and transportation links, is an especially effective strategy. According to UNIDO (2009), regional integration policies could provide a significant boost to African growth by encouraging the growth of large cities

7.1.4 Land use control and development plan guideline:

This includes a) the Regional Development Plan and b) the Expansion Plan or Master Plan. These Proposals must be interpreted within the framework of the approved Perspective Plan. These Plans are prepared for the medium term (generally five years, which coincides with the term of the local authority and/or the term of the Five Year Plan). The same Regional Development Strategy and the Development Plan/Master Plan guide future development in the area, so these Plans should be prepared systematically using scientific approaches as well as process-oriented approaches that involve various stakeholders. The “Guidelines for Formulation and Implementation of Development Plans” should outline the procedures for creating these plans.

This type of plan includes zoning and subdivision regulatory requirements that will be enforced by the corresponding local authorities. The provision stipulates that these plans be advertised in one or more daily papers for citizen feedback before they are adopted and authorised by the state legislature (e.g. regulations for wetland conservation, FAR and density restrictions, ground coverage restrictions, etc.). It's indeed rigid with in sense that this does not change with time. It really is restrictive, in the sense that it focuses on regulations that govern the density of development and the type of land use. According to the West Bengal Town and Country (Planning and Development) Act of 1979, the KMDA has been designated as the statutory planning authority for the Kolkata Metropolitan Area. The Act specifies a specific method for releasing info about this type of plan in one or more local newspapers prior to its acceptance and soliciting public comments.

A Draft Development Plan (DDP) for any municipal area is defined by the West Bengal Municipal Act of 1994 as a written statement that includes the schemes administered by the municipality or the notified area authority for social and economic development.

7.2 Relating guidelines with research findings of micro level areas:

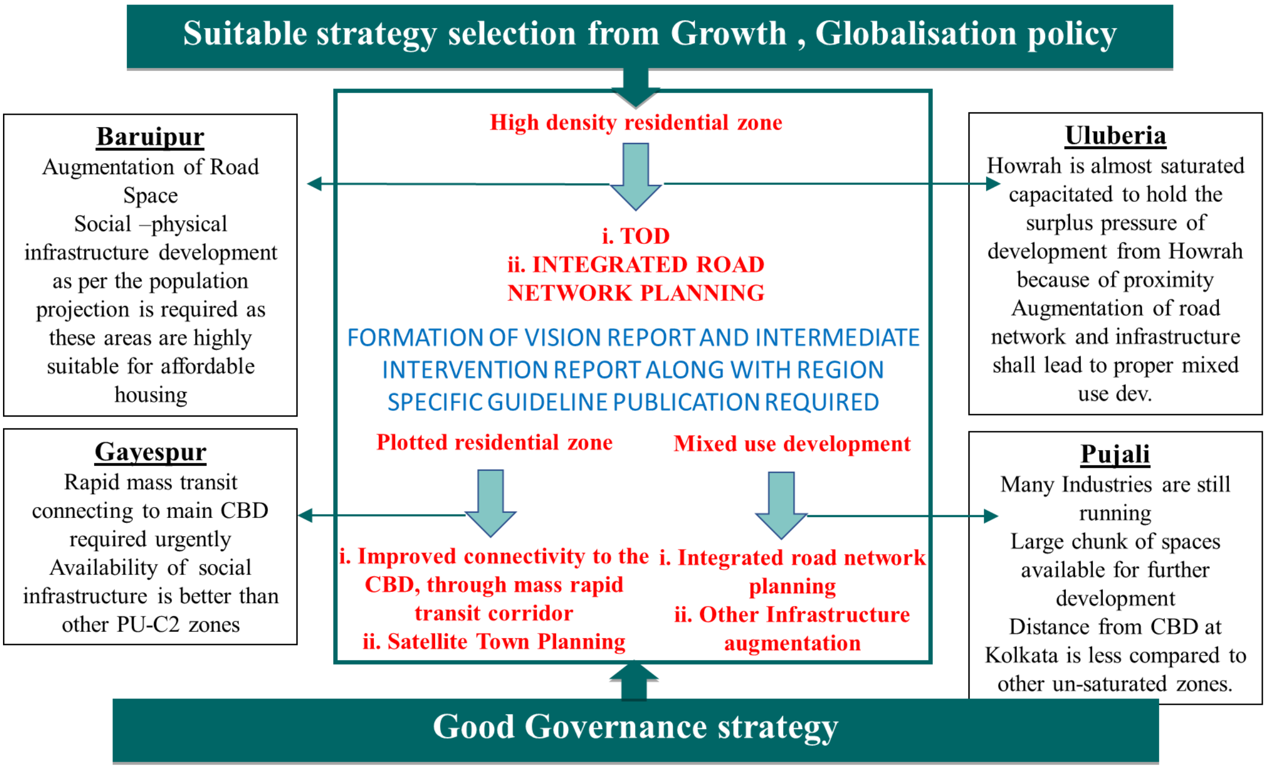


Figure 7. 12Immediate interventions/ policy framing in the un-saturated areas/zones

8 Conclusion

The main purpose of this research is to improve the policy of rural-urban planning related to urban development in the rural-urban fringe area. Thus, the aim of this research is manifested into five research questions, namely: to examine the location of peri-urban area based on remote sensing and comparative score analysis of urban indicators, to examine the growth dynamics of human settlement pattern in peri-urban areas, to identify the physical changes and challenges faced in the peri-urban zone and to examine an appropriate strategy for efficient urban development in the per-urban areas of West Bengal. The entire research has been done in three level- regional level- Urban Area of West Bengal to macro level- Kolkata and its peri-urban domain to micro level- four un-saturated areas in peri urban fringe of KMA

8.1 Location of peri-urban area -outcome of Research Question 1

This research is concerned with land use between urban, rural, and how to find an appropriate model to identify the location of the rural-urban fringe area. Land use as a human activity product on earth's surface shows a large variation, within both local and regional city. An understanding of land use forms that characterize the built-up area, urban-rural transition area, and the countryside itself, is a matter of principle to do its spatial structure differentiation.

The peri-urban area is the most important area in the city because if city center is insufficient for urban population, the target of urban development will move to the rural urban fringe area. In fact, it is difficult to trace boundaries of peri-urban area clearly because of the mixing of urban and provincial properties in an area. This research investigates this problem by assessing urban fringe area through GIS function and urban indicator.

The Kolkata Metropolitan Area was selected inside West Bengal as it proved to be the most important urban center consisting almost half (48.44%) of the total urban population of West Bengal. For the purpose of mapping the peri-urban zones three different models have been considered (i) remote sensing and overlapping the base map to project the LULC change over time (ii) comparative analysis using urbanization indicators (iii)weightage indicator and composite score analysis to identify the rate of urbanization in the demarcated peri-urban zone.
In the first model the LULC mapping of West Bengal the growth of urban settlements is seen predominantly around the city of Kolkata due its primacy. The study of LULC changes shows that the concentration of built-up area is situated along the river belt of Hooghly, but dispersing gradually on the eastern and western side with rural areas. It also showed unpredictability because in some zones reverse growth rate has been observed, which is mainly because of the lack of infrastructure development in these peri-urban areas.

In second model the urbanization scenario has been judged based on three criteria a. total population, b. population density, and c. male workforce share. This study focuses on the peri urban areas of KMA in two consecutive radiuses of 5 kms from the boundary to identify the zone of transition, however the radius in consideration shall vary depending on the city size in each case pertaining to West Bengal or in similar situation.

In third model few urbanization indicators have been chosen and rated with scores. Finally, to identify the areas under rapid urbanization, composite score analysis has been done. Impact of Growth Governance and Globalisation has been also identified in these areas.This model can be varying for each case in consideration depending on what criterion is being taken under consideration, but the outcome will remain same as all the indicators are hyperlinked with each other.

The outcome from these models closely examined and overlapped to find out the results show that mostly Peri-urban zones in this case are closely located to the city core and main transport corridors. And in very few cases they are located far from city center near to the rural area.

8.2 growth dynamics of human settlement pattern in peri-urban areas-outcome of research question 2

In the delineated area after further examination, population density has attained saturation level in few pockets and these zones should come under conservative /no growth strategy to be followed to preserve the existing greens / open spaces. Some zones or pockets are found be having greater scope of development because of availability of land. This research aims to facilitate resources and governance to encourage efficient growth in these pockets.

8.3 Physical changes of peri-urban areas--outcome of research question 2

This research is related to the physical changes in the peri-urban area, and the development pattern of human settlements in the region with higher pace of urbanization.

Much of the urban populations prefer to live in the peri-urban area, as well as housing developers to build housing there due to high demand. This is caused by several things, such as land is cheaper, there is less traffic congestion and pollution, there is easier access, in some places better road infrastructure, and there is better environment with more open space. Many developers are competing with construction in the peri-urban areas because they want to use the land in the region for several purposes, such as affordable housing developments as urban sprawl continue, Educational and institutional development, hyper-markets and superstores, office developments, hotels and conference centers.

If urban development in the area of peri-urban/fringe continues to be left uncontrolled, it would be detrimental for the survival of peri-urban area. As undoubtedly there will be hindrances created by Underutilization of land, uncontrolled encroachment of rural resources, longer travel time to access city core due to congestion created in narrow transportation corridor, buildings maybe out of character with existing rural buildings, villages becoming sub urbanised, increasing traffic, rising levels of pollution. Thus, the final objective of this research is to improve the policy for human settlement development in the peri-urban area.

Physical changes occur in the peri-urban area due to the transition of human settlement pattern resulting in land-use change.

- There is significant change in land use pattern as there is transition from agricultural field to densified human settlement (Identified from LULC mapping over time).
- Built up density increased with varied activities resulting in haphazard/ fuzzy growth due to absence of any land-use control.
- Due to availability of large parcel of land all new institutional educational and recreational developments can be seen in the peri-urban areas.
- Changes in conditions of neighborhood road previously the dirt road/rocks into the asphalt road.
- Demand in physical infrastructure like electricity, water-supply, potable water requirement escalated. In many cases redevelopment of road infrastructure and segmenting them in proper hierarchy is not possible mainly due to non-availability of land along existing transportation corridors.
- There are no urban planning guidelines, or public awareness to lift up the face of the newly constructed urban fabric in these peri-urban areas, resulting in unpleasant built environment.
- Lack of planning initiatives resulted in chaotic layout of new construction with lack of road infrastructure and with little or no setback maintained between properties and right of way.
- The waste disposal system is not well taken care of and needs systematic upgradation by the local body authorities. Meanwhile, the amount of waste increases progressively with increasing number of inhabitant population. And as the development turns out to be having a haphazard pattern with the layout of building not guided with parameters, this also generates inefficient waste disposal system.
- Quality potable water supply has been also affected by the increasing density of the human settlements in fringe areas.

As a result of the influence of the development of 'human-settlements' occurred-specific patterns in the rural-urban fringe areas, namely:

- The pattern of land-use sprawl is mostly linear. This is primarily influenced by the river Hooghly flowing in north-south direction and further by transportation routes (roads) Majorly running in north-south direction only.
- The pattern of built-up/human settlement is scattered constellation. This is influenced by the distance to the urban centers, the travel time, transportation facilities and land values.
- The distribution pattern of other commercial facilities (cafe, copy, store, diner) is mostly ribbon/linear. It is influenced by the transportation routes (roads) and distance to the urban centers.
- The pattern of neighborhood road is mostly organic due to unplanned plot subdivision.
- The pattern of growth of the building in recent times is vertical. This is influenced by the value of land and limited horizontal space.

For the establishment of new human settlements in per-urban, proper planning is required in terms of plot subdivision, road layout that can cater to future traffic load generation. Land is a stagnant resource; hence encroachment of agricultural land is supposed to be reduction of a primary resource. Hence land must be evaluated and comprehensive planning with site and services is essential for optimum usage of land available in peri-urban zones.

As a matter of fact, the development of human settlements in the peri-urban areas projects substantial stimulus on the physical and socio-cultural changes in the rural-urban fringe area. Hence this proves or points out that the generation of peri-urban human settlements triggers new growth of town/city/urban region. Therefore regulatory guidelines related to focused & organized functional planning is very much needed in peri-urban areas.

8.4 An appropriate strategy for peri-urban area -Outcome of Research question 4

This research is concerned with the characteristic of urban development in peri-urban area and how to measure an appropriate strategy for peri-urban area. The main purpose of this research is to improve the policy of rural-urban planning related to urban development in peri-urban area.

The patterns of regional development in peri-urban area can be characterised the following circumstances:

(1) The average of population growth in peri-urban area is higher **(22.74 per cent in PU-C1, & 34.78 in Pu-C2)** considering the average of population growth in the total of the city is only of 4.39 per cent during 2001-2011. The growth is majorly seen in PU-C1 and PU-C2 category of peri-urban areas, which are majorly located nearby the city.

(2) The pattern of human settlements during 1991-2021, generated in the region of KMA is haphazard, sporadic and fuzzy. It is the impact of the leapfrog development of built form changing land-use dynamics without proper planning implementation and easily marketable agricultural land.

(3) The pattern of reduction in agricultural-land over the last 30 years in the study area concentrated mostly in outer fringe area of 73.33 sq.km per year on an average.

(4) The pattern of change in built-up area took a sharp accent from 1991 to 2001 and then on increasing steadily till 2021 within KMA and its surrounding. In the period of 1991-2001 the major settlement generation happened (more than 100%) in kma while the percentage of settlement generation inside Kolkata was around 52%. 2001-2011 31% in KMA and 23% in Kolkata while from 2011-2021 20% in KMA and 8% in Kolkata.

(5) The highest acceleration in the period from 1991 to 2001 experienced by inner fringe area of more than 100%. Acceleration of urban sprawl the lowest experienced by outer fringe area of 22%. The calculation of urban sprawl acceleration shows that the urban process in the inner fringe area is faster than the outer fringe.

Regional development process characterised by the following facts:

Changes by individuals in PU-C1 and PU-C2 affected the housing development in the region.

(1) The majority of farmers in PU-C1 areas do not want to continue agricultural work. While, around 54.51% of farmers in PU-C2 category area still want to maintain their agricultural-land.

(2) In PU-C1 category area the housing development are of Highrise type. where as in PU-C2 still low-density sporadic development has been seen. In PU-C1 category area augmenting transportation corridor is a challenge. Where as in PU-C2 category area consisting unsaturated zone, there is a scope to holistic planning.

The strategy can be proposed are as follows:

(1) Planned utilisation of land, balanced growth of economy, preservation of aqua-agricultural areas and agricultural areas for protection of ecological environment as well as food security in and around the city of Kolkata. Maintaining the essence of riverine civilization, and providing a healthy environment to the city, the rural and the urban -rural interface aka peri-urban.

(2) *The Balanced Growth Strategy* should be adopted to contain further fuzzy/haphazard sprawl and undesirable land conversion at a rapid pace in the unsaturated peri-urban

areas. *The No Growth or Very Slow Growth Strategy* Conservative planning approach / reserve – land development techniques must be adopted in saturated areas.

(3) Need for "Local Regulation" in the imposition of mandatory sanctions from local body authorities for checking perpetrators of violations of land conversion.

(4) Strengthening existing major transportation corridors by following TOD method shall be of major benefit for the peri-urban areas.

(5) Development of human settlements in the peri-urban shall also need major surgery in infrastructure development which includes sewerage/garbage disposal system, water supply and sanitation, medical facility etc.

(6) For efficient development of human settlement and to avoid cluttered/fuzzy/haphazard development a DPR/Vision Report with proposal of proper land use pattern and land use division should be pre-envision for PU-C2 category areas and areas having potential for development.

(7) Public- private participation should be encouraged in preparing such DPR/Vision Report at large and target oriented time schedule with review of progress monitoring should be maintained strictly by the authorities.

(8) As per observation, since majority of the population in the inner fringe areas are no longer committed to preserve agricultural land and agricultural activities, property and taxation laws can be implemented accordingly. This will ensure a dedicated utility of the area despite of changing ownership of the lands.

(9) Utility Outreach Policy and proper law and order implementation by block development authorities are appropriate concepts for the outer fringe area. This concept is appropriate for use in the outer fringe area because agricultural land is still plentiful and farmers are still committed to agrarian farming and forest activities.

8.5 Suggestions /Scope of further research

The entire research is huge in volume containing collection of data, sampling, analysis, and projections to show how the human settlements are being generated and leapfrog development is happening in the peri-urban areas of West Bengal, then to Kolkata Metropolitan Area and further in micro level areas, based on specific indicators related to LULC, Demographic, Occupational, Infrastructure etc. But it is to specially address here that only to project or speculate the growth pattern would not be able to address the issue in a consolidated manner. Hence further research is needed to generate a successful and sustainable planning guideline specially for the peri-urban (The shadow zone). Which may include the following research questions:

- ❑ How to enhance the data base updating programme for Urbanisation indicators/Indices in peri-urban areas?
- ❑ How to generate effective single platform parameter-based tool to assess and forecast efficient urban growth in the fringe?
- ❑ How to cultivate Public-Private-participation mode in generating efficient Development in peri-urban areas?
- ❑ How to create Net-zero, Smart human settlements in the developing peri-urban areas?
- ❑ How to attain sustainability in new peri-urban regions or areas?
- ❑ How to measure loss of urban green open space in peri-urban areas and preservative guidelines can be formed?
- ❑ How to deal with socio-economic impact on human settlements in the peri-urban areas, during the time of changes?

9 Appendix

9.1 Tables

Table 1: Growth Rate in Municipal Areas of KMA

Growth rate							
Name	**1991**	**2001**	**2011**	**2021**	**1991-2001**	**2001-2011**	**2011-2021**
BANKURA	232478	235248	3596674	3975763	0.001191511	1.428886112	0.01054
BARDDHAMAN	2122992	2547048	7717563	8530994	0.019974451	0.203000297	0.01054
BIRBHUM	229563	258420	3502404	3871557	0.012570406	1.255314604	0.01054
Dakshin DINAJPUR	208600	294443	1676276	1852955	0.041151965	0.469304076	0.01054
DARJILING	396060	520432	1846823	2041478	0.031402313	0.25486346	0.01054
East Medinipur	410498	491952	5095875	5632980	0.019842728	0.93584801	0.01054
HOWRAH	1849114	2151990	4850029	5361222	0.01637952	0.125374142	0.01054
HUGLI	1358251	1687749	5519145	6100863	0.024258992	0.227012192	0.01054
JALPAIGURI	458247	606882	3872846	4281044	0.032435564	0.538154699	0.01054
KOCH BIHAR	169497	225618	2819086	3116218	0.033110321	1.149495164	0.01054
Kolkata	4399819	4572876	4496694	4970646	0.003933275	-0.001665954	0.01054
MALDAH	186537	240940	3988845	4409269	0.029164723	1.555534573	0.01054
MURSHIDABAD	494347	732734	7103807	7852548	0.048222605	0.869493295	0.01054
NADIA	871818	979519	5167600	5712265	0.012353611	0.42756506	0.01054
NORTH 24 PARAGANAS	3730300	4850947	10009781	11064812	0.030041739	0.106346946	0.01054
PURULIYA	210006	255426	2930115	3,238,949	0.021627953	1.047148293	0.01054
SOUTH 24 PARAGANAS	760377	1086220	8161961	9022232	0.042852822	0.651409567	0.01054
Uttar Dinajpur	208600	196854	3007134	3324086	-0.005630872	1.427596086	0.01054
West Medinipur	410497	491953	5913457	6536735	0.019843263	1.102036983	0.01054

Table 2: Percentage of Urbanisation in Municipal areas of KMA, 2021.

Number	Municipality	Area	Urban	%
1	Kolkata	182.067	149.1786	81.9361
2	Howrah	47.6393	39.2418	82.37275
3	Bidhannagar	60.8199	36.5553	60.10418
4	Chandannagore	22.8843	10.5525	46.1124
5	Kalyani	25.989	13.9428	53.64885
6	Gayespur	23.2853	7.3845	31.71314
7	Kanchrapara	9.83037	5.7231	58.21856
8	Halisahar	9.44361	6.7788	71.78187
9	Naihati	4.46469	3.6882	82.6082
10	Bhatpara	21.8785	14.2875	65.30384
11	Garulia	3.76861	3.2499	86.23604
12	North Barrackpur	11.9761	7.4844	62.49447
13	Barrackpore	12.9553	8.9415	69.01809
14	Titagarh	3.67757	2.5443	69.18427
15	Khardah	4.26155	3.2652	76.62001
16	Panihati	19.8681	15.5403	78.21734
17	Kamarhati	10.2921	8.6733	84.27143
18	North Dumdum	7.92259	6.9633	87.89171
19	South Dumdum	14.4026	12.7557	88.56526
20	Dumdum	15.3014	12.0123	78.50458
21	Baranagar	8.06679	6.6276	82.15907
22	New Barrackpore	3.97323	2.9619	74.5464
23	Madhyamgram	25.5547	15.5853	60.988
24	Barasat	34.0907	17.0244	49.93855
25	Baruipur	5.73465	0.6156	10.73474
26	Rajpur Sonarpur	46.2556	22.6701	49.0105
27	Budge Budge	42.5529	20.9664	49.27138
28	Maheshtala	7.88347	3.7008	46.9438
29	Pujali	7.50519	2.5191	33.56477
30	Uluberia	33.9581	10.8504	31.95232
31	Bally	10.1137	9.0675	89.65562
32	Uttarpara Kotrung	10.206	6.273	61.46384
33	Konnagar	5.51531	3.9906	72.35495
34	Rishra	3.01448	2.6631	88.34359
35	Serampore	6.67517	5.3505	80.15526
36	Baidyabati	10.8505	6.4305	59.26455
37	Champdani	5.12737	3.0564	59.60951

38	Bhadreswar	10.4014	4.3668	41.98281
39	Hugli Chuchura	11.9221	10.1061	84.76778
40	Bansberia	7.57361	4.9014	64.71683

Table 3.1: Land Use Land Cover Comparative Analysis of KMA, 1991.

Sl. No.	Name of Municipality	LULC Classes (Area in Sq. Km)					
	Municipality	**Hoogly River**	**Inland Water bodies**	**Built Up**	**Vegetation**	**Agricultural Land**	**Fallow Land**
1	Baidyabati	0.0009	0.0054	0.2925	1.3572	8.5824	0.6102
2	Bally	0.0099	0.1215	2.8845	0.8514	5.7006	0.5454
3	Bansberia	0.5526	0.0702	1.1484	1.0503	3.5838	1.1565
4	Baranagar	0.9126	0.0720	2.5488	0.1818	3.8358	0.5184
5	Barasat	0.0117	0.2412	0.7380	11.8071	14.1048	7.1955
6	Barrackpore	1.4094	0.0567	1.4868	1.4976	7.5087	0.9954
7	Baruipur	0.0036	0.0009	1.5921	2.7585	1.1745	0.2169
8	Bhadreswar	0.0288	0.0495	0.5355	3.4119	4.7997	1.5768
9	Bhatpara	0.1521	0.1863	2.7981	5.8464	10.3599	2.5290
10	Bidhannagar	0.1215	9.0747	8.2863	6.0768	30.1932	7.0605
11	Budge Budge	4.3650	0.0450	3.5982	12.5928	21.5046	0.4581
12	Champdani	0.0063	0.0360	0.4293	0.5247	3.4992	0.6309
13	Chandannagore	0.0720	0.0927	0.7020	8.9145	9.0630	4.0356
14	Dumdum	0.0063	0.0846	0.7092	4.6053	7.7184	2.1573
15	Garulia	0.2124	0.0027	0.5877	0.3303	2.4048	0.2259
16	Gayespur	0.0279	1.4517	1.0323	3.0996	10.4877	7.1775
17	Halisahar	0.0027	0.0306	0.4005	4.1472	3.3579	1.5282
18	Howrah	0.0936	0.1728	14.3838	4.0491	27.4059	1.5372
19	Hugli Chuchura	0.0432	0.0621	0.5571	3.5829	5.6754	1.9953
20	Kalyani	0.0288	0.1314	1.2321	2.4903	17.9154	4.1967
21	Kamarhati	0.6651	0.1737	2.2464	0.5544	5.6016	1.0557
22	Kanchrapara	0.0531	0.2412	0.5859	1.7253	5.5710	1.6524
23	Khardah	0.4203	0.0324	0.3690	0.5049	2.5020	0.4257
24	Kolkata	5.6178	3.3291	73.1682	9.1503	85.9509	4.8483
25	Konnagar	0.0279	0.0018	0.5706	0.2466	4.4451	0.2232
26	Madhyamgram	0.0207	0.0594	0.9837	6.5736	12.9798	4.9455
27	Maheshtala	3.1680	0.0099	0.9702	1.0206	2.6298	0.0819
28	Naihati	0.0009	0.0153	0.4950	0.6597	2.3328	0.9414
29	New Barrackpore	0.0072	0.0279	0.0279	2.0412	1.2258	0.6480
30	North	0.7740	0.1440	1.7811	1.6290	7.0632	0.5913

	Barrackpur						
31	North Dumdum	0.0018	0.0819	0.6075	1.5183	4.6026	1.1025
32	Panihati	1.1727	0.0909	1.7721	3.2634	10.9728	2.5983
33	Pujali	2.9691	0.0009	0.6282	1.2249	2.5263	0.1575
34	Rajpur Sonarpur	0.0297	0.2268	0.6660	18.5796	22.5639	4.1751
35	Rishra	0.0018	0.0000	1.0557	0.1008	1.7640	0.0900
36	Serampore	0.0018	0.0063	1.4940	0.3420	4.5882	0.2421
37	South Dumdum	0.0036	0.0873	3.6162	0.6561	8.4411	1.5939
38	Titagarh	0.7398	0.0027	1.3428	0.1224	1.2600	0.2070
39	Uluberia	0.0405	0.0117	0.4968	13.8852	18.4158	1.0926
40	Uttarpara Kotrung	0.0099	0.0585	2.5812	0.4095	6.6276	0.5148

Table 3.2: Land Use Land Cover Comparative Analysis of KMA, 2001.

Sl. No.	Name of Municipality	LULC Classes (Area in Sq. Km)					
	Municipality	**Hoogly River**	**Inland Water bodies**	**Built Up**	**Vegetation**	**Agricultural Land**	**Fallow Land**
1	Baidyabati	0.0081	0.0657	1.6245	1.7379	3.7719	3.6405
2	Bally	0.0036	0.1683	7.4466	0.7011	0.9981	0.7956
3	Bansberia	0.6201	0.1485	1.827	1.4769	2.5047	0.9846
4	Baranagar	0.9324	0.1089	6.4422	0.0657	0.1998	0.3204
5	Barasat	0.099	0.4626	8.9415	6.885	14.3586	3.3516
6	Barrackpore	1.2384	0.18	6.1002	0.8226	3.222	1.3914
7	Baruipur	0.0018	0.0144	0.0054	3.0816	0.6948	1.9485
8	Bhadreswar	0.0351	0.1503	1.8369	2.2095	4.2849	1.8855
9	Bhatpara	0.1683	0.5202	7.2315	5.8734	5.832	2.2464
10	Bidhannagar	0.0657	9.4104	31.5837	2.7756	7.6392	9.3384
11	Budge Budge	4.3983	0.2025	6.4719	13.662	9.0945	8.7345
12	Champdani	0.0009	0.0486	1.2339	0.6804	1.332	1.8306
13	Chandannagore	0.0063	0.2916	4.0824	4.9959	10.9566	2.547
14	Dumdum	0.0117	0.1989	8.4465	1.2006	2.898	2.5254
15	Garulia	0.2151	0.0144	1.9782	0.2871	1.1025	0.1665
16	Gayespur	0.0468	1.4994	1.9773	0.765	14.13	4.8582
17	Halisahar	0.0027	0.1152	1.4436	4.0392	2.5893	1.2771
18	Howrah	0.0819	0.6525	28.4274	4.3074	8.6193	5.5539
19	Hugli Chuchura	0.0315	0.1737	3.6243	2.4219	4.7187	0.9459

20	Kalyani	0.0693	0.3429	3.9114	1.1034	15.6753	4.8924
21	Kamarhati	0.6831	0.3087	7.9911	0.279	0.6228	0.4122
22	Kanchrapara	0.0036	0.8586	2.3139	1.08	3.4443	2.1285
23	Khardah	0.3816	0.0909	2.4804	0.3447	0.6966	0.2601
24	Kolkata	5.7222	5.1039	111.6702	10.4382	23.8788	25.2513
25	Konnagar	0	0.0648	2.286	0.3312	1.2915	1.5417
26	Madhyamgram	0.0171	0.1467	13.023	2.8935	7.1208	2.3616
27	Maheshtala	3.2742	0.0369	2.115	0.9027	1.0098	0.5418
28	Naihati	0.0009	0.0603	2.38	0.4842	1.17	0.3717
29	New Barrackpore	0.0045	0.0738	1.3842	1.6398	0.6786	0.1971
30	North Barrackpur	0.8937	0.5877	3.7764	1.8414	3.4218	1.4616
31	North Dumdum	0.0063	0.1179	5.7123	0.162	0.9243	0.9918
32	Panihati	1.1169	0.2439	11.9457	1.4544	2.8701	2.2392
33	Pujali	2.9646	0.0666	1.5858	1.0377	1.4661	0.3861
34	Rajpur Sonarpur	0.0117	0.3339	2.4372	10.9152	12.708	19.8351
35	Rishra	0.0009	0.0207	1.9323	0.1602	0.6786	0.2196
36	Serampore	0.0018	0.0414	3.3525	0.5724	1.3392	1.3671
37	South Dumdum	0.0063	0.1593	12.56	0.1494	0.9288	0.6048
38	Titagarh	0.7524	0.0189	2.3409	0.1503	0.2889	0.1233
39	Uluberia	0.0045	0.1575	2.844	12.6126	9.126	9.198
40	Uttarpara Kotrung	0.0252	0.1791	5.9742	0.5211	1.7919	1.71

Table 3.3: Land Use Land Cover Comparative Analysis of KMA, 2011.

Sl. No.	**Name of Municipality**	**LULC Classes (Area in Sq. Km)**					
	Municipality	**Hoogly River**	**Inland Water bodies**	**Built Up**	**Vegetation**	**Agricultural Land**	**Fallow Land**
1	Baidyabati	0	0.0477	5.454	0.054	4.428	0.8649
2	Bally	0	0.1332	8.523	0.0063	1.3086	0.1422
3	Bansberia	0.5625	0.0513	5.0409	0.018	1.5588	0.3303
4	Baranagar	0.9234	0.0801	6.5385	0	0.4608	0.0666
5	Barasat	0.0135	0.2511	16.9254	0.1773	10.8225	5.9085
6	Barrackpore	1.3194	0.0747	7.5744	0.0702	3.1797	0.7362
7	Baruipur	0	0.0009	1.1475	1.0296	3.24	0.3285
8	Bhadreswar	0.0288	0.1503	4.7997	0.1413	3.8682	1.4139
9	Bhatpara	0.1458	0.3276	12.3633	0.2142	7.7364	1.0845
10	Bidhannagar	0.0405	10.8162	40.1526	0.4518	6.3396	3.0123
11	Budge Budge	4.3983	0.1224	11.5983	2.6802	22.4424	1.3221

12	Champdani	0	0.1053	2.844	0.0216	1.7919	0.3636
13	Chandannagore	0	0.171	10.8603	0.5094	8.6373	2.7018
14	Dumdum	0.1044	11.5641	0.0135	3.0735	0.5256	0
15	Garulia	0.1953	0.0063	3.0726	0.3519	0.1377	0
16	Gayespur	0.0018	0.9558	5.7888	0.0486	4.9581	11.5236
17	Halisahar	0.0441	6.1974	0.045	3.0087	0.1719	0
18	Howrah	0.0684	0.4599	33.6375	0.6273	11.0061	1.8432
19	Hugli Chuchura	0.0027	0.063	10.1637	0.0009	1.3293	0.3564
20	Kalyani	0.216	11.2464	0.009	4.7313	9.792	0
21	Kamarhati	0.6606	0.2448	8.4438	0.0099	0.7767	0.1611
22	Kanchrapara	0.0009	0.4968	4.7322	0.0432	3.3723	1.1835
23	Khardah	0.3906	0.0513	3.3471	0	0.4257	0.0396
24	Kolkata	5.5512	4.3299	137.8692	1.0782	27.468	5.7681
25	Konnagar	0.2079	3.5793	0.0603	1.4103	0.2574	0
26	Madhyamgram	0.0027	0.1116	15.2919	0.0072	5.3199	4.8294
27	Maheshtala	3.2409	0.0414	2.2203	0.2439	1.971	0.1629
28	Naihati	0.0045	0.0342	3.6774	0.0036	0.6642	0.0612
29	New Barrackpore	0	0.0432	2.9313	0.0018	0.8865	0.1152
30	North Barrackpur	0.7272	0.5058	5.9778	0.126	4.041	0.6048
31	North Dumdum	0	0.0702	6.8643	0.0072	0.819	0.1539
32	Panihati	1.0809	0.3717	15.1857	0.0414	2.8665	0.324
33	Pujali	2.9889	0.0099	1.791	0.3555	1.9287	0.4329
34	Rajpur Sonarpur	0	0.1656	12.3039	1.5642	28.332	3.8754
35	Rishra	0	0.0144	2.5263	0.0018	0.3879	0.0819
36	Serampore	0	0.0234	5.0679	0.0018	1.3905	0.1908
37	South Dumdum	0	0.1188	13.0005	0.0153	1.0656	0.198
38	Titagarh	0.7308	0.0378	2.752	0.325	0.423	0.1263
39	Uluberia	0	0.0567	3.303	4.6791	22.4703	3.4335
40	Uttarpara Kotrung	0.0216	0.2925	6.4728	0.0855	2.7153	0.6138

Table 3.4: Land Use Land Cover Comparative Analysis of KMA, 2021.

Sl. No.	Name of Municipality	LULC Classes (Area in Sq. Km)					
	Municipality	Hoogly River	Inland Water bodies	Built Up	Vegetation	Agricultural Land	Fallow Land
1	Baidyabati	0	0.1683	6.4305	0.3834	3.8043	0.0621
2	Bally	0	0.2313	9.0675	0.1998	0.612	0.0027
3	Bansberia	0.4662	0.3906	4.9014	0.8424	0.8091	0.1521
4	Baranagar	0.8397	0.2232	6.6276	0.0783	0.2988	0.0018
5	Barasat	0	0.8874	17.0244	7.6752	7.848	0.6633
6	Barrackpore	1.3131	0.2466	8.9415	0.7839	1.6605	0.009
7	Baruipur	0	0.0567	0.6156	3.1122	1.9386	0.0234
8	Bhadreswar	0.0153	0.2916	4.3668	2.2932	3.258	0.1773
9	Bhatpara	0.1017	0.7722	14.2875	3.1032	3.4992	0.108
10	Bidhannagar	0	11.5758	36.5553	3.3444	8.0649	1.2726
11	Budge Budge	4.2534	3.865	21.716	2.6829	14.256	0
12	Champdani	0	0.1728	3.0564	0.2808	1.6056	0.0108
13	Chandannagore	0	0.4293	10.5525	6.354	5.3775	0.1665
14	Dumdum	0	0.2178	12.0123	0.7191	2.1105	0.2214
15	Garulia	0.1998	0.0792	3.2499	0.0945	0.1305	0.0099
16	Gayespur	0	1.1286	7.3845	3.4983	8.7633	2.502
17	Halisahar	0	0.1179	6.7788	1.6128	0.8649	0.0927
18	Howrah	0.0576	0.882	39.2418	2.6046	4.8474	0.009
19	Hugli Chuchura	0	0.2295	10.1061	0.729	0.7677	0.0837
20	Kalyani	0	0.8757	13.9428	4.2066	4.9491	2.0205
21	Kamarhati	0.6039	0.306	8.6733	0.2034	0.5058	0.0045
22	Kanchrapara	0	0.3186	5.7231	1.6245	1.7766	0.3861
23	Khardah	0.4149	0.1404	3.2652	0.1197	0.3114	0.0027
24	Kolkata	5.1237	5.9832	149.1786	4.5666	16.7445	0.468
25	Konnagar	0	0.5022	3.9906	0.1098	0.9117	0.0009
26	Madhyamgram	0	0.3357	15.5853	3.5208	4.8078	1.3131
27	Maheshtala	3.105	0.1539	3.7008	0.2358	0.675	0.0099
28	Naihati	0	0.1053	3.6882	0.3816	0.2502	0.0198
29	New Barrackpore	0	0.0414	2.9619	0.5742	0.387	0.0135
30	North Barrackpur	0.6633	0.9504	7.4844	0.9522	1.7649	0.1674
31	North Dumdum	0.0009	0.1017	6.9633	0.3159	0.3996	0.1332
32	Panihati	1.026	0.4806	15.5403	0.6102	2.1816	0.0315
33	Pujali	2.7891	0.2187	2.5191	1.3509	0.6273	0.0018
34	Rajpur Sonarpur	0	0.7443	22.6701	8.7048	13.8483	0.2736

35	Rishra	0	0.0063	2.6631	0.0972	0.2457	0
36	Serampore	0	0.0774	5.3505	0.0747	1.1691	0.0027
37	South Dumdum	0	0.2106	12.7557	0.5364	0.8379	0.0576
38	Titagarh	0.7002	0.0918	2.5443	0.2025	0.1359	0
39	Uluberia	0	0.7191	10.8504	11.4507	10.9224	0
40	Uttarpara Kotrung	0	0.9711	6.273	0.5895	2.3553	0.0126

Table 4: Housing Price Calculation of KMA.

Name of Statutory Town	mean price (Rs/sft)	median price (Rs/sft)	minimum price (Rs/sft)	range	standard deviation	kurtosis	skewness
Kolkata	3887.255	3300	2400	7400	1544.145	3.811	1.82
South Dum Dum	2545.24	2400	1750	2250	582.65	0.88	1.097
Baranagar	2585.185	2500	2000	1600	370.2429	1.128	1.117
Kamarhati	2693.33	2500	2000	2200	644.99	1.75	1.5275
Howrah	2505.56	2350	1700	2800	707.9675	1.603	1.386
Bally	2379.03	2300	1700	1550	440.41	-1.045	0.3032
Bidhannagar	3781.82	3000	2500	3500	1347.456	-1.216	0.6545
Rajarhat Gopalpur	3253.57	3050	2400	2100	567.47	-0.5979	0.5669
North Dum Dum	2966	3000	2000	1800	602.22	1.056	-0.421
Panihati	2111.46	2000	1300	3800	730.84	12.5977	3.14
Madhyamgram	2150	2150	1200	1600	384.71	1.463	-0.63
Khardah	1995.83	2050	1350	1150	388.7382	-1.125	-0.2374
Titagarh	2093.75	2050	1800	700	256.9568	-1.075	0.55
Barasat	1888.46	1800	1450	1550	384.14	6.119	2.132
Barrackpur	2560	2700	1600	1700	585.3774	-1.006	-0.498
Rajpur Sonarpur	2387.5	2275	1900	1300	376.55	-0.61	0.74
North Barrackpur	1837.5	1600	1500	1800	612.226	6.364	2.488
Maheshtala	2250	2050	1200	2000	603.324	-0.46979	0.07847
Garulia	2050	2000	1800	600	250	-1.27	0.6

Budge Budge	1796	1750	1250	1250	370.18	-0.77	0.455
Uttarpara Kotrung	2280	2000	1450	2050	683.75	-1.13	0.516
Konnagar	1877.78	1850	1250	1250	335.73	-0.379	0.1144
Serampore	1772.22	1725	1350	1150	333.088	0.83	1.036
Baidyabati	1450	1425	1200	600	228.0351	-0.78	0.55
Champdani	1531	1425	1200	800	322.86	-1.82	0.485
Bhadreswar	1519.231	1500	1000	1000	278.79	-0.353	-0.1569
Bhatpara	1431.25	1450	1100	650	232.89	-1.47	-0.10125
Naihati	1707.143	1700	1350	850	261.5465	-0.6577	0.515
Halisahar	2075	2050	1800	700	260.494	-0.716	0.6869
Kanchrapara	2475	2500	1900	1100	328.42	0.81	-0.286
Baruipur	2157.69	2000	1200	2400	668.28	0.3056	0.7163
Kalyani	2542.857	2600	2000	1000	415.76	-1.3133	-0.40551
Gayespur	1375	1375	1000	800	282.4	-0.298	0.2747
Chandannagar	1887.5	1900	1250	1450	394.33	-0.15	0.42
Hoogly Chinsurah	1945	1950	1750	450	148.04	-0.9947	0.31398
Uluberia	1481.25	1500	1000	1000	327.25	-0.54499	0.14998
KUA		**2200**			**951.827**	**11.244**	**2.4873**

Table 5.1: Ward Wise Population Data-Baruipur.

Ward	*Population 2011*	*Density(per sq.km.)*	*Literacy(%)*	*Total Female_worker (%)*	*Non agriculture Population(%)*	*Population growth rate/year*
1	3735	10210.28	5.658033	0.591025	2.33775	4.635579937
2	3820	7075.207	6.307409	0.449857	2.296341	2.290862291
3	2420	11555.66	3.892486	0.353862	1.330748	-0.086030315
4	3971	5217.031	6.55963	0.478091	2.219169	3.166445623
5	3517	5655.156	5.77285	0.380214	1.982006	1.112164297
6	3143	6407.724	5.057597	0.566556	1.953772	1.326126126
7	2122	5532.784	3.421924	0.312453	1.294986	1.47647377
8	3535	4633.998	5.373814	0.579732	2.030944	0.923980222

9	2439	3043.987	3.973423	0.263515	1.396627	1.985257985
10	4815	4561.938	7.781208	0.570321	2.930658	2.548866302
11	2117	6855.545	3.35981	0.3181	1.3571	0.974598237
12	3113	5459.619	5.036892	0.39339	1.961301	5.64321608
13	3336	8469.12	5.354992	0.939241	2.017768	1.709371709
14	3873	10255.63	6.499398	0.641846	2.373513	1.19687771
15	1949	7609.567	3.214877	0.378332	1.28181	0.06714876
16	3410	3654.173	5.477338	0.415977	2.047884	1.923076923
17	1813	7606.506	2.776314	0.146815	0.997591	-0.060307018

Table 5.2: Ward Wise Population Data- Uluberia.

Ward	***Population 2011***	***Literacy(%)***	***Total Female_worker (%)***	***Non agriculture Population(%)***	***Population growth rate/year***
1	7156	2.076101	0.186535	0.443604	-2.97398
2	4909	1.413669	0.101978	0.417685	-1.9722
3	8789	2.556247	0.237949	0.76186	2.748767
4	8512	2.352291	0.250271	0.537084	9.540863
5	4516	1.52542	0.097304	0.470373	-1.40791
6	5999	1.921434	0.197582	0.627164	-2.26634
7	9365	3.043617	0.226476	1.028703	4.053121
8	7535	1.841977	0.181861	0.698974	2.129749
9	7531	2.308526	0.146593	0.69345	-1.48655
10	11733	3.629565	0.249846	1.077992	7.333432
11	7722	2.513756	0.173363	0.949245	0.681975
12	8590	2.572394	0.251121	0.883384	2.26267
13	7536	2.433024	0.156791	0.470798	3.595526
14	6024	1.888717	0.122798	0.471648	2.031156
15	5946	1.732775	0.164439	0.433406	1.839904
16	6741	2.068028	0.131722	0.59912	-1.17901
17	7843	2.107969	0.132996	1.01723	1.109065
18	6128	1.867471	0.14022	0.400263	-1.64781
19	8902	2.37991	0.154667	0.728717	-2.13535
20	13072	4.011133	0.426608	1.097538	11.88149
21	7902	2.317449	0.294036	0.806476	-1.85025
22	11648	3.537785	0.205231	0.797128	4.281511
23	9318	3.090357	0.234549	0.695575	6.816459
24	5968	1.855999	0.099004	0.630989	-2.36633
25	8209	2.223969	0.269392	0.87871	0.875729

26	7294	2.205273	0.117275	0.881684	2.413206
27	6037	1.977522	0.061612	0.795853	-3.15533
28	11315	3.135822	0.328029	0.275765	1.615851
29	10123	3.035968	0.343751	1.043999	#DIV/0!
30	2982	0.963267	0.04674	0.324205	#DIV/0!

Table 5.3: Ward Wise Population Data- Gayespur.

Ward	*Population 2011*	*Density(per sq.km.)*	*Literacy(%)*	*Total Female_worker (%)*	*Non agriculture Population(%)*	*Population growth rate/year*
1	2958	1258.458	4.145903	0.244076	1.22377	1.26428
2	2592	7275.473	3.906912	0.233906	1.259365	-0.27757
3	3416	8202.319	4.96966	0.298315	1.611919	-0.16129
4	3065	2097.615	4.513712	0.264416	1.481406	0.57991
5	1750	3116.399	2.632293	0.254246	0.747483	0.876321
6	2182	5588.43	3.334011	0.128818	1.010204	0.659502
7	3062	3156.897	4.581511	0.372894	1.430557	0.584169
8	4509	822.5542	5.866301	0.766128	1.55768	2.130751
9	5068	1340.136	7.173125	0.554256	1.983118	3.64934
10	2499	10472.15	3.859453	0.149158	1.208516	1.057522
11	1984	10904.04	2.867894	0.257636	0.886471	-0.15385
12	3484	5339.753	5.179837	0.271196	1.796671	0.205038
13	3458	6763.404	4.834062	0.615275	1.400047	0.252001
14	3522	2098.252	4.657785	0.555951	1.58141	0.6792
15	3995	7322.336	5.764602	0.733923	1.386488	0.390117
16	3487	2900.888	5.173057	0.269501	1.652598	-0.1078
17	4619	1543.223	5.944269	0.589851	2.483135	-1.15981
18	3348	537.6889	4.196752	0.422048	1.598359	3.648594

Table 5.4: Ward Wise Population Data- Pujali.

Ward	*Population 2011*	*Density(per sq.km.)*	*Literacy(%)*	*Total Female_worker (%)*	*Non agriculture Population(%)*	*Population growth rate/year*
1	2256	4379.6286	4.753421	0.283423759	1.778821497	-0.191304348
2	1755	4029.850457	3.789781	0.218641186	1.255162361	0.694698355
3	3330	4781.504072	7.090993	0.458876562	2.510324723	1.659663866

4	2882	4127.853366	5.520015	0.361702702	2.013658326	1.639741519
5	1443	2653.991459	3.187842	0.14576079	0.958242233	0.471698113
6	2470	5812.36567	4.98016	0.242934651	1.24706454	1.645450259
7	2506	5841.646188	4.8344	0.242934651	0.674818474	1.765258216
8	2912	3786.422481	4.764218	0.707209761	1.908386644	0.753323486
9	2576	5597.663039	4.100197	0.696412665	1.74643021	0.773734839
10	2414	5874.534151	4.64815	0.321213594	1.481901369	1.992051664
11	1940	4432.641682	4.086701	0.224039733	1.516991929	0.671067107
12	4190	4359.235286	5.773747	1.498097012	1.457607903	-0.511775362
13	1627	2805.626021	2.688477	0.423786002	1.141792858	1.555397727
14	1431	2922.505375	3.077172	0.118768051	0.955542959	1.058732612
15	3315	7075.17162	6.321699	0.753097417	2.526520366	1.368312757

Table 6.1: Weightage of Indicators & Composite Score analysis POP-Baruipur.

Ward	*Density(per sq.km.) (< 6694:1 or >6694:2)*		*Literacy(%) (< 85 : 1 or > 85: 2)*		*Total Female_worker (%) (< 8: 1 or > 8: 2)*		*Non agriculture Population(%) (< 32 : 1 or > 32: 2)*		*Decadal Population growth rate (%) (< 18 : 1 or > 18: 2)*		*Composite Score*
1	10210.28438	2	80.48192771	1	8.406961178	2	33.25301205	2	46.35579937	2	90
2	7075.206844	2	87.72251309	2	6.256544503	1	31.93717277	1	22.90862291	2	80
3	11555.6588	2	85.45454545	2	7.768595041	1	29.21487603	1	-0.860303154	1	70
4	5217.030827	1	87.7612692	2	6.396373709	1	29.69025434	1	31.66445623	2	70
5	5655.156144	1	87.20500426	2	5.743531419	1	29.94029002	1	11.12164297	1	60
6	6407.723654	1	85.49156857	2	9.576837416	2	33.02577156	2	13.26126126	1	80
7	5532.783899	1	85.67389255	2	7.822808671	1	32.42224317	2	14.7647377	1	70
8	4633.99847	1	80.76379066	1	8.712871287	2	30.52333805	1	9.239802225	1	60
9	3043.987297	1	86.55186552	2	5.740057401	1	30.42230422	1	19.85257985	2	70
10	4561.93837	1	85.85669782	2	6.292834891	1	32.3364486	2	25.48866302	2	80
11	6855.544917	2	84.31743033	1	7.982994804	1	34.05762872	2	9.745982374	1	70
12	5459.619334	1	85.96209444	2	6.713780919	1	33.47253453	2	56.4321608	2	80
13	8469.120206	2	85.28177458	2	14.95803357	2	32.13429257	2	17.09371709	1	90
14	10255.63146	2	89.15569326	2	8.804544281	2	32.55873999	2	11.9687771	1	90
15	7609.567231	2	87.63468445	2	10.31298102	2	34.94099538	2	0.671487603	1	90
16	3654.173451	1	85.3372434	2	6.480938416	1	31.90615836	1	19.23076923	2	70
17	7606.506077	2	81.35686707	1	4.302261445	1	29.23331495	1	-0.603070175	1	60

Table 6.2: Weightage of Indicators & Composite Score analysis POP - Uluberia.

Ward	*Literacy(%) (< 71: 1 or > 71: 2)*		*Total Female_worker (%) (< 6 : 1 or > 6: 2)*		*Non agriculture Population(%) (< 21 : 1 or > 21 : 2)*		*Decadal Population growth rate(%) (< 15 : 1 or > 15: 2)*		*Composite Score*
1	68.2783678	1	6.13471213	2	14.58915595	1	-29.73981345	1	50
2	67.7734773	1	4.888979426	1	20.0244449	1	-19.72199509	1	40
3	68.4491979	1	6.371600865	2	20.40050063	1	27.48767044	2	60
4	65.037594	1	6.919642857	2	14.84962406	1	95.40863177	2	60
5	79.4951284	2	5.070859167	1	24.51284322	2	-14.07914764	1	60
6	75.3792299	2	7.751291882	2	24.60410068	2	-22.6634008	1	70
7	76.4869194	2	5.691404164	1	25.85157501	2	40.53121248	2	70
8	57.5315196	1	5.680159257	1	21.83145322	2	21.29748873	2	60
9	72.1418138	2	4.581064932	1	21.67042889	2	-14.86547592	1	60
10	72.8032046	2	5.011506009	1	21.62277337	2	73.33431822	2	70
11	76.6122766	2	5.283605284	1	28.93032893	2	6.81975377	1	60
12	70.4772992	1	6.880093132	2	24.20256112	2	22.62669522	2	70
13	75.9819533	2	4.896496815	1	14.70276008	1	35.95525889	2	60
14	73.7881806	2	4.79747676	1	18.42629482	1	20.31156381	2	60
15	68.583922	1	6.508577195	2	17.15438951	1	18.39904421	2	60
16	72.1999703	2	4.598724225	1	20.91677793	1	-11.7901073	1	50
17	63.2538569	1	3.990819839	1	30.52403417	2	11.09065156	1	50
18	71.7199739	2	5.385117493	1	15.37206266	1	-16.47812457	1	50
19	62.9184453	1	4.088968771	1	19.26533363	1	-21.35347646	1	40
20	72.2154223	2	7.680538556	2	19.75979192	1	118.8148644	2	70
21	69.0205011	1	8.757276639	2	24.01923564	2	-18.50247525	1	60
22	71.4800824	2	4.146634615	1	16.10576923	1	42.81510544	2	60
23	78.0532303	2	5.92401803	1	17.56814767	1	68.16459123	2	60
24	73.1903485	2	3.904155496	1	24.88270777	2	-23.66334101	1	60
25	63.7592886	1	7.723230601	2	25.19186259	2	8.757286698	1	60
26	71.1543735	2	3.783931999	1	28.44803948	2	24.13206263	2	70
27	77.0912705	2	2.401855226	1	31.02534371	2	-31.55328798	1	60
28	65.2231551	1	6.822801591	2	5.735749006	1	16.15850529	2	60
29	70.5818433	1	7.991702065	2	24.27146103	2	`--		
30	76.0228035	2	3.688799463	1	25.58685446	2			

Table 6.3: Weightage of Indicators & Composite Score analysis POP - Gayespur.

Ward	*Density(per sq.km.) (< 4486:1 or >4486:2)*		*Literacy(%) (< 84 : 1 or > 84: 2)*		*Total Female_worker (%) (< 7: 1 or > 7: 2)*		*Non agriculture Population(%) (< 26 : 1 or > 26 : 2)*		*Decadal Population growth rate (%) (< 8 : 1 or > 8: 2)*		*Composite Score*
1	1258.458	1	82.69101	1	4.868154	1	24.40838	1	12.6428	2	60
2	7275.473	2	88.92747	2	5.324074	1	28.66512	2	-2.77569	1	80
3	8202.319	2	85.83138	2	5.152225	1	27.83958	2	-1.6129	1	80
4	2097.615	1	86.88418	2	5.089723	1	28.5155	2	5.799103	1	70
5	3116.399	1	88.74286	2	8.571429	2	25.2	1	8.763207	2	80
6	5588.43	2	90.14665	2	3.483043	1	27.31439	2	6.595017	1	80
7	3156.897	1	88.27564	2	7.184847	2	27.56368	2	5.841687	1	80
8	822.5542	1	76.7576	1	10.0244	2	20.38146	1	21.30751	2	70
9	1340.136	1	83.50434	1	6.452249	1	23.08603	1	36.4934	2	60
10	10472.15	2	91.11645	2	3.521409	1	28.53141	2	10.57522	2	90
11	10904.04	2	85.28226	2	7.66129	2	26.36089	2	-1.53846	1	90
12	5339.753	2	87.71527	2	4.592423	1	30.4248	2	2.050381	1	80
13	6763.404	2	82.47542	1	10.4974	2	23.88664	1	2.520012	1	70
14	2098.252	1	78.02385	1	9.31289	2	26.49063	2	6.791995	1	70
15	7322.336	2	85.13141	2	10.83855	2	20.47559	1	3.90117	1	80
16	2900.888	1	87.52509	2	4.559794	1	27.961	2	-1.07801	1	70
17	1543.223	1	75.92553	1	7.534098	2	31.71682	2	-11.5981	1	70
18	537.6889	1	73.9546	1	7.437276	2	28.16607	2	36.48594	2	80

Table 6.4: Weightage of Indicators & Composite Score analysis POP - Pujali.

Ward	*Density(per sq.km.) (< 4565:1 or >4565:2)*		*Literacy(%) (< 71 : 1 or > 71: 2)*		*Total Female_worker (%) (< 6: 1 or > 6: 2)*		*Non agriculture Population(%) (< 24 : 1 or > 24 : 2)*		*Decadal Population growth rate (%) (< 10 : 1 or > 10 : 2)*		*Composite Score*
1	4379.629	1	78.05851	2	4.654255	1	29.21099	2	-1.91304	1	70
2	4029.85	1	80	2	4.615385	1	26.49573	2	6.946984	1	70
3	4781.504	2	78.88889	2	5.105105	1	27.92793	2	16.59664	2	90
4	4127.853	1	70.95767	1	4.649549	1	25.8848	2	16.39742	2	70
5	2653.991	1	81.84338	2	3.742204	1	24.60152	2	4.716981	1	70
6	5812.366	2	74.69636	2	3.643725	1	18.70445	1	16.4545	2	80
7	5841.646	2	71.46848	2	3.591381	1	9.976057	1	17.65258	2	80
8	3786.422	1	60.61126	1	8.997253	2	24.27885	2	7.533235	1	70
9	5597.663	2	58.96739	1	10.01553	2	25.11646	2	7.737348	1	80
10	5874.534	2	71.33389	2	4.929577	1	22.74234	1	19.92052	2	80
11	4432.642	1	78.04124	2	4.278351	1	28.96907	2	6.710671	1	70
12	4359.235	1	51.05012	1	13.24582	2	12.88783	1	-5.11775	1	60
13	2805.626	1	61.21696	1	9.649662	2	25.99877	2	15.55398	2	80
14	2922.505	1	79.66457	2	3.074773	1	24.73795	2	10.58733	2	80
15	7075.172	2	70.64857	1	8.41629	2	28.23529	2	13.68313	2	90

Table 7.1.1: Chi-Square Test Observed Value - Baruipur.

Observed Value						
	Distance	**1991**	**2001**	**2011**	**2021**	
East	1km	0.0045	0	0	0.0315	
	2km	0	0	0	0	
North-East	1km	0.013	0.019	0.0243	0.0414	
North	1km	0.047	0.0548	0.0648	0.0558	
	2km	0.0402	0.057	0.0675	0.1719	
	3km	0	0	0	0.0189	
North-West	1km	0	0	0	0.018	
	2km	0	0	0.0063	0.0351	
	3km	0	0	0	0	
South	1km	0	0.003	0.0072	0.0387	
	2km	0.0183	0.0289	0.0379	0.0414	

Sout-East	1km	0.008	0.011	0.015	0.018	
	2km	0.0125	0.053	0.089	0.0927	
	3km		0		0	
South-West	1km	0.009	0.012	0.0162	0.0378	
	2km	0.0023	0.0056	0.0063	0.0063	
West	1km	0	0	0	0	
	2km	0	0	0	0	

Table 7.1.2: Chi-Square Test Expected Value - Baruipur.

Expected Value			
1991	**2001**	**2011**	**2021**
0.004155	0.006558	0.008979	0.016308
0	0	0	0
0.011277	0.017797	0.024369	0.044257
0.025671	0.040513	0.055471	0.100744
0.038853	0.061316	0.083955	0.152475
0.002182	0.003443	0.004714	0.008561
0.002078	0.003279	0.00449	0.008154
0.004779	0.007542	0.010326	0.018754
0	0	0	0
0.005644	0.008908	0.012197	0.022151
0.014602	0.023044	0.031552	0.057303
0.006002	0.009473	0.01297	0.023555
0.028534	0.045031	0.061657	0.111978
0	0	0	0
0.008657	0.013662	0.018707	0.033974
0.002366	0.003734	0.005113	0.009286
0	0	0	0
0	0	0	0

Table 7.1.3: Chi-Square Test Chi-Square - Baruipur.

Chi-Square			
1991	**2001**	**2011**	**2021**
2.86E-05	0.006558	0.008979	0.014154
0	0	0	0
0.000263	8.13E-05	1.93E-07	0.000184
0.017721	0.005038	0.001569	0.020051
4.67E-05	0.000304	0.003225	0.002475
0.002182	0.003443	0.004714	0.012485
0.002078	0.003279	0.00449	0.01189

0.004779	0.007542	0.00157	0.014248
0	0	0	0
0.005644	0.003918	0.002047	0.012364
0.000937	0.001488	0.001277	0.004413
0.000665	0.000246	0.000318	0.00131
0.00901	0.00141	0.012126	0.003319
0	0	0	0
1.36E-05	0.000202	0.000336	0.000431
1.86E-06	0.000932	0.000275	0.00096
0	0	0	0
0	0	0	0

Table 7.2.1: Chi-Square Test Observed Value - Uluberia.

Observed Value					
	Distance	**1991**	**2001**	**2011**	**2021**
East	1km	0	0.0162	0.0153	0.0531
	2km	0	0.0945	0.0603	0.3132
	3km	0	0.0927	0.0567	0.306
	5km	0.1791	0.8361	0.792	1.9278
	7km	0.2898	0.873	0.5562	1.2159
North-East	1km	0	0.0234	0	0.1152
	2km	0	0.0288	0.0738	0.2997
	3km	0	0.0486	0.0144	0.1854
	5km	0	0.0225	0	0.0324
	7km	0	0	0	0
North	1km	0	0.009	0.0369	0.1539
	2km	0	0.005	0.0126	0.09
	3km	0	0	0	0
	5km	0	0	0	0
	7km	0	0	0	0
North-West	1km	0.0126	0.0369	0.0702	0.1854
	2km	0.0216	0.2385	0.0531	0.2574
	3km	0.007	0.1053	0.0153	0.2772
	5km	0	0.0189	0.0153	0.2763
	7km	0.004	0.0099	0.0162	0.1989
South	1km	0	0.1026	0.0279	0.0315
	2km	0.1179	0.1935	0.2718	0.3474
	3km	0	0	0	0
	5km	0	0	0	0
	7km	0	0	0	0

Sout-East	1km	0	0.0441	0.0225	0.0756
	2km	0.0684	0.2448	0.414	0.6075
	3km	0.0288	0.2673	0.2475	0.6012
	5km	0.1287	0.4311	0.2853	0.7047
	7km	0	0	0	0
South-West	1km	0	0.0198	0.0081	0.0558
	2km	0.0837	0.1989	0.2601	0.4482
	3km	0.0945	0.2547	0.2979	0.5283
	5km	0.1395	0.8685	1.0566	1.746
	7km	0	0	0	0
West	1km	0.0171	0.0135	0.045	0.1197
	2km	0.006	0.0729	0.0909	0.3285
	3km	0	0.0963	0.1188	0.5211
	5km	0.1845	0.5004	1.1565	2.3751
	7km	0.1656	0.1296	0.3681	1.7577

Table 7.2.2: Chi-Square Test Expected Value - Uluberia.

Expected Value			
1991	**2001**	**2011**	**2021**
0.004362	0.016607	0.01819	0.045441
0.024128	0.091871	0.100626	0.251375
0.023478	0.089397	0.097917	0.244608
0.192559	0.7332	0.803072	2.006169
0.15131	0.576136	0.63104	1.576414
0.007146	0.027208	0.029801	0.074446
0.020741	0.078974	0.0865	0.216086
0.012806	0.048762	0.053409	0.133422
0.00283	0.010777	0.011804	0.029488
0	0	0	0
0.010301	0.039222	0.04296	0.107318
0.005547	0.021122	0.023135	0.057795
0	0	0	0
0	0	0	0
0	0	0	0
0.01573	0.059893	0.0656	0.163877
0.029417	0.112012	0.122686	0.306485
0.02087	0.079464	0.087037	0.217429
0.016008	0.060953	0.066761	0.166778
0.011806	0.044954	0.049238	0.123002
0.008352	0.031801	0.034832	0.087015
0.047977	0.182682	0.200091	0.49985
0	0	0	0

0	0	0	0
0	0	0	0
0.007331	0.027915	0.030575	0.076379
0.068811	0.262008	0.286977	0.716903
0.059021	0.22473	0.246146	0.614903
0.0799	0.304234	0.333226	0.832439
0	0	0	0
0.004315	0.016431	0.017997	0.044958
0.051086	0.194519	0.213056	0.532239
0.060598	0.230737	0.252726	0.631339
0.196457	0.74804	0.819327	2.046776
0	0	0	0
0.010069	0.038338	0.041992	0.104901
0.02569	0.097819	0.107141	0.26765
0.037955	0.14452	0.158292	0.395433
0.217383	0.827721	0.9066	2.264796
0.124815	0.475255	0.520545	1.300384

Table 7.2.3: Chi-Square Test Chi-Square - Uluberia.

Chi-Square			
1991	**2001**	**2011**	**2021**
0.004362	9.99E-06	0.000459	0.001291
0.024128	7.52E-05	0.016161	0.015205
0.023478	0.000122	0.01735	0.015408
0.000941	0.014441	0.000153	0.003061
0.126757	0.152964	0.008876	0.082447
0.007146	0.000533	0.029801	0.02231
0.020741	0.031876	0.001865	0.032354
0.012806	5.39E-07	0.028492	0.020249
0.00283	0.012752	0.011804	0.000288
0	0	0	0
0.010301	0.023287	0.000855	0.020219
0.005547	0.012306	0.004798	0.017946
0	0	0	0
0	0	0	0
0	0	0	0
0.000623	0.008827	0.000323	0.002827
0.002077	0.142836	0.039468	0.007861
0.009218	0.0084	0.059127	0.016431
0.016008	0.029013	0.039668	0.071922
0.005161	0.027334	0.022168	0.046832
0.008352	0.157617	0.00138	0.035418

0.101906	0.000641	0.025699	0.046496
0	0	0	0
0	0	0	0
0	0	0	0
0.007331	0.009385	0.002133	7.95E-06
2.45E-06	0.00113	0.056223	0.016696
0.015474	0.008064	7.44E-06	0.000305
0.029804	0.052904	0.006893	0.019602
0	0	0	0
0.004315	0.000691	0.005442	0.002615
0.020821	9.87E-05	0.010388	0.01327
0.018967	0.002489	0.008075	0.016817
0.016513	0.019398	0.068713	0.044199
0	0	0	0
0.00491	0.016092	0.000215	0.002088
0.015091	0.006348	0.002462	0.013834
0.037955	0.016089	0.009853	0.039937
0.004974	0.129438	0.068883	0.005372
0.013327	0.251396	0.044645	0.160827

Table 7.3.1: Chi-Square Test Observed Value - Gayespur.

Observed Value					
	Distance	**1991**	**2001**	**2011**	**2021**
East	1km	0	0.0198	0.0738	0.0936
	2km	0.0666	0.0396	0.2457	0.414
	3km	0.1161	0.0999	0.2295	0.3924
	5km	0.0252	0.0153	0.0162	0.0819
North-East	1km	0.0198	0.045	0.0216	0.1008
	2km	0.0297	0.0567	0.2115	0.4725
	3km	0.0225	0.0099	0.0315	0.0486
North	1km	0.0369	0.108	0.1305	0.144
	2km	0.0333	0.1611	0.5661	0.5832
North-West	1km	0.0054	0.0576	0.0594	0.1575
	2km	0.009	0.0216	0.0828	0.2079
	3km	0	0.0252	0.0306	0.0405
South	1km	0	0.0315	0.1593	0.1656
	2km	0.0621	0.0522	0.4698	0.5862
	3km	0.0936	0.1152	0.3843	0.3222
Sout-East	1km	0.0054	0.0234	0.2421	0.2349
	2km	0.1017	0.072	0.3834	0.333

	3km	0.09	0.4347	0.5058	0.252
South-West	1km	0	0.0333	0.0063	0.1152
	2km	0.0198	0.0756	0.3087	0.4239
	3km	0.2052	0.0972	0.3177	0.4734
	5km	0.0207	0.0144	0.1035	0.1242
West	1km	0.0126	0.0234	0.0099	0.2151
	2km	0.009	0.1557	0.441	0.5598
	3km	0.0207	0.1413	0.5148	0.6021
	5km	0.018	0.0423	0.189	0.2124

Table 7.3.2: Chi-Square Test Expected Value - Gayespur.

Expected Value			
1991	**2001**	**2011**	**2021**
0.011908	0.022947	0.066735	0.085611
0.048719	0.093882	0.273035	0.350263
0.053299	0.102708	0.298702	0.38319
0.008816	0.016989	0.049409	0.063385
0.011908	0.022947	0.066735	0.085611
0.049006	0.094434	0.274639	0.352321
0.007156	0.01379	0.040105	0.051449
0.026678	0.051409	0.149511	0.191801
0.085474	0.164708	0.479014	0.614504
0.017805	0.03431	0.099781	0.128005
0.020438	0.039384	0.11454	0.146938
0.006126	0.011804	0.03433	0.04404
0.022671	0.043687	0.127053	0.16299
0.074444	0.143453	0.417199	0.535204
0.058223	0.112196	0.326294	0.418587
0.032174	0.062	0.180312	0.231314
0.05662	0.109107	0.317311	0.407063
0.081581	0.157206	0.457197	0.586516
0.009847	0.018975	0.055184	0.070794
0.05267	0.101495	0.295173	0.378663
0.069558	0.134039	0.389821	0.500082
0.016717	0.032213	0.093685	0.120184
0.016602	0.031993	0.093044	0.119361
0.074138	0.142865	0.415488	0.533009
0.081352	0.156765	0.455914	0.58487
0.029369	0.056594	0.164591	0.211146

Table 7.3.3: Chi-Square Test Chi-Square - Gayespur.

Chi-Square			
1991	**2001**	**2011**	**2021**
0.011908	0.000431	0.000748	0.000746
0.006562	0.031386	0.002737	0.011598
0.073995	7.68E-05	0.016032	0.000221
0.030445	0.000168	0.022321	0.005408
0.005231	0.021195	0.030526	0.002695
0.007605	0.015078	0.014516	0.040994
0.032899	0.001097	0.001846	0.000158
0.003916	0.062295	0.002417	0.011913
0.031847	7.9E-05	0.015832	0.001595
0.008642	0.01581	0.016342	0.006796
0.006401	0.008031	0.008795	0.025292
0.006126	0.015202	0.000405	0.000285
0.022671	0.0034	0.008185	4.18E-05
0.002047	0.058048	0.006632	0.004859
0.021496	8.05E-05	0.010312	0.022195
0.022281	0.024032	0.021173	5.56E-05
0.035892	0.01262	0.013765	0.013475
0.000869	0.48982	0.005167	0.190789
0.009847	0.010814	0.043304	0.027855
0.020513	0.006607	0.00062	0.005404
0.264507	0.010125	0.013343	0.001424
0.000949	0.009851	0.001028	0.000134
0.000965	0.002308	0.074297	0.076792
0.057231	0.001153	0.001567	0.001347
0.045219	0.001526	0.007606	0.000508
0.004401	0.00361	0.00362	7.45E-06

Table 7.4.1: Chi-Square Test Observed Value - Pujali.

Observed Value					
	Distance	**1991**	**2001**	**2011**	**2021**
East	1km	0.0045	0.1332	0.2538	0.2556
	2km	0.0378	0.2115	0.1557	0.3024
North-East	1km	0.0801	0.1575	0.2673	0.1674
	2km	0.0234	0.0279	0.0351	0.0378
North	1km	0.0297	0.0513	0.1035	0.1359
North-West	1km	0.0684	0.0657	0.0855	0.2178
	2km	0.0612	0.0171	0.036	0.0747
South	1km	0.0045	0.1575	0.1503	0.1098
	2km	0	0.0378	0.0063	0.0054
Sout-East	1km	0	0.162	0.153	0.1026
	2km	0	0.018	0.0153	0.0432
South-West	1km	0	0.1089	0.0585	0.1584
	2km	0.0099	0.0603	0.0603	0.1953
	3km	0	0.0072	0.0063	0.0126
West	1km	0	0.1386	0.0954	0.1692
	2km	0.3492	0.2268	0.3024	0.4995

Table 7.4.2: Chi-Square Test Expected Value - Pujali.

Expected Value			
1991	**2001**	**2011**	**2021**
0.066344	0.156886	0.177066	0.246803
0.072526	0.171506	0.193566	0.269802
0.068928	0.162996	0.183962	0.256415
0.012734	0.030112	0.033985	0.04737
0.032849	0.077679	0.087671	0.1222
0.044845	0.106046	0.119686	0.166824
0.019377	0.045822	0.051716	0.072084
0.043276	0.102336	0.115499	0.160989
0.005075	0.012001	0.013545	0.018879
0.042815	0.101245	0.114268	0.159272
0.007843	0.018547	0.020933	0.029177
0.033403	0.078989	0.089149	0.12426
0.033403	0.078989	0.089149	0.12426
0.002676	0.006328	0.007142	0.009955
0.041338	0.097754	0.110328	0.15378
0.141269	0.334065	0.377035	0.52553

Table 7.4.3: Chi-Square Test Chi-Square - Pujali.

Chi-Square			
1991	**2001**	**2011**	**2021**
0.057649	0.003576	0.033253	0.000314
0.016627	0.009326	0.007408	0.003939
0.001811	0.000185	0.037754	0.030902
0.008935	0.000162	3.66E-05	0.001933
0.000302	0.008958	0.002858	0.001536
0.012373	0.01535	0.009765	0.015577
0.090268	0.018004	0.004776	9.49E-05
0.034744	0.029736	0.010486	0.016276
0.005075	0.055461	0.003875	0.009624
0.042815	0.036458	0.013128	0.020165
0.007843	1.61E-05	0.001516	0.00674
0.033403	0.011327	0.010537	0.00938
0.016537	0.004422	0.009336	0.040614
0.002676	0.00012	9.92E-05	0.000703
0.041338	0.017067	0.00202	0.001546
0.306047	0.034442	0.014774	0.001289

Table 8.1.1: Shanon's Entropy Index Calculator – Baruipur, 1991

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.0045	0.37531	0.053040253
	2km	0	1.12601	0
North-East	1km	0.013	0.391627	0.113040435
North	1km	0.047	0.407945	0.248970532
	2km	0.0402	1.22394	0.112196456
	3km	0	2.03994	0
North-West	1km	0	0.375309	0
	2km	0	1.12601	0
	3km	0	1.87673	0
South	1km	0	0.399786	0
	2km	0.0183	1.19946	0.063815283
South-East	1km	0.008	0.391627	0.079481105
	2km	0.0125	1.17499	0.048333244
	3km		1.95834	0
South-West	1km	0.009	0.424263	0.081737415
	2km	0.0023	1.27288	0.011412776
West	1km	0	0.375309	0
	2km	0	1.12601	0

Table 8.1.2: Shanon's Entropy Index Calculator – Baruipur, 2001

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0	0.37531	0
	2km	0	1.12601	0
North-East	1km	0.019	0.391627	0.146801795
North	1km	0.0548	0.407945	0.269663388
	2km	0.057	1.22394	0.142822698
	3km	0	2.03994	0
North-West	1km	0	0.375309	0
	2km	0	1.12601	0
	3km	0	1.87673	0
South	1km	0.003	0.399786	0.036712019
	2km	0.0289	1.19946	0.089769722
South-East	1km	0.011	0.391627	0.100341806
	2km	0.053	1.17499	0.139773376
	3km	0	1.95834	0

South-West	1km	0.012	0.424263	0.100846321
	2km	0.0056	1.27288	0.023872726
West	1km	0	0.375309	0
	2km	0	1.12601	0

Table 8.1.3: Shanon's Entropy Index Calculator – Baruipur, 2011

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0	0.37531	0
	2km	0	1.12601	0
North-East	1km	0.0243	0.391627	0.172485437
North	1km	0.0648	0.407945	0.292247175
	2km	0.0675	1.22394	0.159807623
	3km	0	2.03994	0
North-West	1km	0	0.375309	0
	2km	0.0063	1.12601	0.029014913
	3km	0	1.87673	0
South	1km	0.0072	0.399786	0.072341974
	2km	0.0379	1.19946	0.109159293
South-East	1km	0.015	0.391627	0.124950258
	2km	0.089	1.17499	0.195451613
	3km		1.95834	0
South-West	1km	0.0162	0.424263	0.124683381
	2km	0.0063	1.27288	0.026273861
West	1km	0	0.375309	0
	2km	0	1.12601	0

Table 8.1.4: Shanon's Entropy Index Calculator – Baruipur, 2021

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.0315	0.37531	0.20796033
	2km	0	1.12601	0
North-East	1km	0.0414	0.391627	0.237539801
North	1km	0.0558	0.407945	0.272110711
	2km	0.1719	1.22394	0.275687961
	3km	0.0189	2.03994	0.043374124
North-West	1km	0.018	0.375309	0.145674105
	2km	0.0351	1.12601	0.108111858

	3km	0	1.87673	0
South	1km	0.0387	0.399786	0.22604087
	2km	0.0414	1.19946	0.116191218
South-East	1km	0.018	0.391627	0.141560428
	2km	0.0927	1.17499	0.200363599
	3km	0	1.95834	0
South-West	1km	0.0378	0.424263	0.215437311
	2km	0.0063	1.27288	0.026273861
West	1km	0	0.375309	0
	2km	0	1.12601	0

Table 8.2.1: Shanon's Entropy Index Calculator –Uluberia, 1991

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0	0.395318	0
	2km	0	1.18606	0
	3km	0	1.9768	0
	5km	0.1791	6.32583	0.100918519
	7km	0.2898	9.48879	0.106548687
North-East	1km	0	0.389976	0
	2km	0	1.17003	0
	3km	0	1.95009	0
	5km	0	6.24034	0
	7km	0	0	0
North	1km	0	0.389976	0
	2km	0	1.17244	0
	3km	0	1.95007	0
	5km	0	0	0
	7km	0	0	0
North-West	1km	0.0126	0.395318	0.109834413
	2km	0.0216	1.18404	0.073043374
	3km	0.007	1.9768	0.019983444
	5km	0	6.32582	0
	7km	0.004	9.48879	0.003276107
South	1km	0	0.422029	0
	2km	0.1179	1.2662	0.221045159
	3km	0	0	0
	5km	0	0	0
	7km	0	0	0
South-East	1km	0	0.363266	0

	2km	0.0684	1.08989	0.1737447
	3km	0.0288	1.81652	0.065705806
	5km	0.1287	5.81292	0.084362521
	7km	0	0	0
South-West	1km	0	0.395318	0
	2km	0.0837	1.18606	0.187091312
	3km	0.0945	1.9768	0.145356126
	5km	0.1395	6.32529	0.084120632
	7km	0	0	0
West	1km	0.0171	0.389976	0.137115656
	2km	0.006	1.17004	0.027040274
	3km	0	1.95015	0
	5km	0.1845	6.24034	0.104104972
	7km	0.1656	9.36066	0.071378047

Table 8.2.2: Shanon's Entropy Index Calculator – Uluberia, 2001

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.0162	0.395318	0.130916892
	2km	0.0945	1.18606	0.201562632
	3km	0.0927	1.9768	0.143489273
	5km	0.8361	6.32583	0.267470411
	7km	0.873	9.48879	0.219513511
North-East	1km	0.0234	0.389976	0.168811339
	2km	0.0288	1.17003	0.091183121
	3km	0.0486	1.95009	0.092011935
	5km	0.0225	6.24034	0.020282337
	7km		0	0
North	1km	0.009	0.389976	0.086979059
	2km	0.005	1.17244	0.023273704
	3km	0	1.95007	0
	5km		0	0
	7km		0	0
North-West	1km	0.0369	0.395318	0.221359952
	2km	0.2385	1.18404	0.32275338
	3km	0.1053	1.9768	0.156203944
	5km	0.0189	6.32582	0.017368516
	7km	0.0099	9.48879	0.00716285
South	1km	0.1026	0.422029	0.343816714
	2km	0.1935	1.2662	0.287071058

	3km		0	0
	5km		0	0
	7km		0	0
South-East	1km	0.0441	0.363266	0.255990355
	2km	0.2448	1.08989	0.335430176
	3km	0.2673	1.81652	0.281983495
	5km	0.4311	5.81292	0.192933308
	7km		0	0
South-West	1km	0.0198	0.395318	0.149958691
	2km	0.1989	1.18606	0.299440035
	3km	0.2547	1.9768	0.264021684
	5km	0.8685	6.32529	0.272626962
	7km		0	0
West	1km	0.0135	0.389976	0.116432394
	2km	0.0729	1.17004	0.172941834
	3km	0.0963	1.95015	0.14854704
	5km	0.5004	6.24034	0.202344814
	7km	0.1296	9.36066	0.059254844

Table 8.2.3: Shanon's Entropy Index Calculator – Uluberia, 2011

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.0153	0.395318	0.125855935
	2km	0.0603	1.18606	0.151457196
	3km	0.0567	1.9768	0.101865544
	5km	0.792	6.32583	0.260146958
	7km	0.5562	9.48879	0.166279781
North-East	1km	0	0.389976	0
	2km	0.0738	1.17003	0.174303936
	3km	0.0144	1.95009	0.036244992
	5km	0	6.24034	0
	7km	0	0	0
North	1km	0.0369	0.389976	0.223104852
	2km	0.0126	1.17244	0.048716893
	3km	0	1.95007	0
	5km	0	0	0
	7km	0	0	0
North-West	1km	0.0702	0.395318	0.306916513
	2km	0.0531	1.18404	0.139226307
	3km	0.0153	1.9768	0.037626033

	5km	0.0153	6.32582	0.014571312
	7km	0.0162	9.48879	0.010880234
South	1km	0.0279	0.422029	0.179582163
	2km	0.2718	1.2662	0.33029626
	3km	0	0	0
	5km	0	0	0
	7km	0	0	0
South-East	1km	0.0225	0.363266	0.172288215
	2km	0.414	1.08989	0.367686608
	3km	0.2475	1.81652	0.271581734
	5km	0.2853	5.81292	0.147942677
	7km		0	0
South-West	1km	0.0081	0.395318	0.079660916
	2km	0.2601	1.18606	0.332745807
	3km	0.2979	1.9768	0.285192653
	5km	1.0566	6.32529	0.298924691
	7km		0	0
West	1km	0.045	0.389976	0.249179493
	2km	0.0909	1.17004	0.19849964
	3km	0.1188	1.95015	0.17046307
	5km	1.1565	6.24034	0.312393006
	7km	0.3681	9.36066	0.127249664

Table 8.2.4: Shanon's Entropy Index Calculator – Uluberia, 2021

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.0531	0.395318	0.269653724
	2km	0.3132	1.18606	0.351619247
	3km	0.306	1.9768	0.288794397
	5km	1.9278	6.32583	0.362123403
	7km	1.2159	9.48879	0.263281244
North-East	1km	0.1152	0.389976	0.360218731
	2km	0.2997	1.17003	0.348873283
	3km	0.1854	1.95009	0.223716623
	5km	0.0324	6.24034	0.027313329
	7km	0	0	0
North	1km	0.1539	0.389976	0.366928924
	2km	0.09	1.17244	0.197053102
	3km	0	1.95007	0
	5km	0	0	0
	7km	0	0	0

North-West	1km	0.1854	0.395318	0.355107072
	2km	0.2574	1.18404	0.33175137
	3km	0.2772	1.9768	0.275474566
	5km	0.2763	6.32582	0.1367522
	7km	0.1989	9.48879	0.08101784
South	1km	0.0315	0.422029	0.193695752
	2km	0.3474	1.2662	0.354834918
	3km		0	0
	5km		0	0
	7km		0	0
South-East	1km	0.0756	0.363266	0.32666899
	2km	0.6075	1.08989	0.325786571
	3km	0.6012	1.81652	0.365961852
	5km	0.7047	5.81292	0.25580321
	7km	0	0	0
South-West	1km	0.0558	0.395318	0.276364214
	2km	0.4482	1.18606	0.367744464
	3km	0.5283	1.9768	0.35265531
	5km	1.746	6.32529	0.355319809
	7km		0	0
West	1km	0.1197	0.389976	0.362528108
	2km	0.3285	1.17004	0.356636713
	3km	0.5211	1.95015	0.35264256
	5km	2.3751	6.24034	0.367661862
	7km	1.7577	9.36066	0.314055872

Table 8.3.1: Shanon's Entropy Index Calculator – Gayespur, 1991

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0	0.391857	0
	2km	0.0666	1.15771	0.164269067
	3km	0.1161	1.95949	0.16744008
	5km	0.0252	6.27044	0.022171059
North-East	1km	0.0198	0.391857	0.150838846
	2km	0.0297	1.17568	0.092925041
	3km	0.0225	1.95949	0.051291813
North	1km	0.0369	0.398178	0.220438025
	2km	0.0333	1.19464	0.099791924
North-West	1km	0.0054	0.385537	0.059782813
	2km	0.009	1.15671	0.037783882
	3km	0	1.9275	0

South	1km	0	0.410473	0
	2km	0.0621	1.23256	0.150549402
	3km	0.0936	2.05423	0.140731754
South-East	1km	0.0054	0.379217	0.060543784
	2km	0.1017	1.13775	0.215849868
	3km	0.09	1.89628	0.144654572
South-West	1km	0	0.385537	0
	2km	0.0198	1.1567	0.069628564
	3km	0.2052	1.9275	0.238467843
	5km	0.0207	6.1692	0.01911623
West	1km	0.0126	0.398177	0.10927381
	2km	0.009	1.19464	0.036827312
	3km	0.0207	1.99108	0.047472922
	5km	0.018	6.37133	0.016581381

Table 8.3.2: Shanon's Entropy Index Calculator – Gayespur, 2001

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.0198	0.391857	0.150838846
	2km	0.0396	1.15771	0.115456077
	3km	0.0999	1.95949	0.151738134
	5km	0.0153	6.27044	0.014678549
North-East	1km	0.045	0.391857	0.24853595
	2km	0.0567	1.17568	0.146217197
	3km	0.0099	1.95949	0.026716267
North	1km	0.108	0.398178	0.353899348
	2km	0.1611	1.19464	0.270186761
North-West	1km	0.0576	0.385537	0.284030329
	2km	0.0216	1.15671	0.074333118
	3km	0.0252	1.9275	0.056703401
South	1km	0.0315	0.410473	0.197018226
	2km	0.0522	1.23256	0.133903575
	3km	0.1152	2.05423	0.16156402
South-East	1km	0.0234	0.379217	0.171874463
	2km	0.072	1.13775	0.174669487
	3km	0.4347	1.89628	0.337666457
South-West	1km	0.0333	0.385537	0.211534448
	2km	0.0756	1.1567	0.178289082
	3km	0.0972	1.9275	0.150638991
	5km	0.0144	6.1692	0.014145333
West	1km	0.0234	0.398177	0.166557481
	2km	0.1557	1.19464	0.265573793

	3km	0.1413	1.99108	0.187745253
	5km	0.0423	6.37133	0.033293683

Table 8.3.3: Shanon's Entropy Index Calculator – Gayespur, 2011

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.0738	0.391857	0.314430832
	2km	0.2457	1.15771	0.328974096
	3km	0.2295	1.95949	0.251173072
	5km	0.0162	6.27044	0.015394321
North-East	1km	0.0216	0.391857	0.159755215
	2km	0.2115	1.17568	0.308589269
	3km	0.0315	1.95949	0.066399541
North	1km	0.1305	0.398178	0.365605663
	2km	0.5661	1.19464	0.353897522
North-West	1km	0.0594	0.385537	0.288165262
	2km	0.0828	1.15671	0.188755953
	3km	0.0306	1.9275	0.065771808
South	1km	0.1593	0.410473	0.367334234
	2km	0.4698	1.23256	0.367642633
	3km	0.3843	2.05423	0.31358528
South-East	1km	0.2421	0.379217	0.286496249
	2km	0.3834	1.13775	0.366543905
	3km	0.5058	1.89628	0.352489482
South-West	1km	0.0063	0.385537	0.067227663
	2km	0.3087	1.1567	0.352536753
	3km	0.3177	1.9275	0.29715813
	5km	0.1035	6.1692	0.068579786
West	1km	0.0099	0.398177	0.091854081
	2km	0.441	1.19464	0.367877254
	3km	0.5148	1.99108	0.349732951
	5km	0.189	6.37133	0.104352987

Table 8.3.4: Shanon's Entropy Index Calculator – Gayespur, 2021

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.0936	0.391857	0.342019444
	2km	0.414	1.15771	0.367734539

	3km	0.3924	1.95949	0.32204355
	5km	0.0819	6.27044	0.056661195
North-East	1km	0.1008	0.391857	0.349265342
	2km	0.4725	1.17568	0.366353175
	3km	0.0486	1.95949	0.091689805
North	1km	0.144	0.398178	0.367826352
	2km	0.5832	1.19464	0.350059611
North-West	1km	0.1575	0.385537	0.365712874
	2km	0.2079	1.15671	0.308473313
	3km	0.0405	1.9275	0.081161309
South	1km	0.1656	0.410473	0.366213859
	2km	0.5862	1.23256	0.353456665
	3km	0.3222	2.05423	0.29055671
South-East	1km	0.2349	0.379217	0.296677237
	2km	0.333	1.13775	0.35960939
	3km	0.252	1.89628	0.268204857
South-West	1km	0.1152	0.385537	0.360945504
	2km	0.4239	1.1567	0.367876752
	3km	0.4734	1.9275	0.344836204
	5km	0.1242	6.1692	0.078625197
West	1km	0.2151	0.398177	0.332659099
	2km	0.5598	1.19464	0.355203178
	3km	0.6021	1.99108	0.361671546
	5km	0.2124	6.37133	0.113381663

Table 8.4.1: Shanon's Entropy Index Calculator –Pujali, 1991

	Distance	Urban Area	Total Area	Shanon
East	1km	0.0045	0.398924	0.050588886
	2km	0.0378	1.19945	0.108955181
North-East	1km	0.0801	0.391627	0.324598211
	2km	0.0234	1.17443	0.078020632
North	1km	0.0297	0.391627	0.195597177
North-West	1km	0.0684	0.399787	0.302071456
	2km	0.0612	1.19915	0.15184383
South	1km	0.0045	0.384401	0.052066046
	2km	0	1.17467	0
South-East	1km	0	0.398853	0
	2km	0	1.17499	0
South-West	1km	0	0.391627	0

	2km	0.0099	1.17443	0.0402599
	3km	0	1.95815	0
West	1km	0	0.383468	0
	2km	0.3492	1.15035	0.361896904

Table 8.4.2: Shanon's Entropy Index Calculator – Pujali, 2001

	Distance	Urban Area	Total Area	Shanon
East	1km	0.1332	0.398924	0.366259
	2km	0.2115	1.19945	0.306003
North-East	1km	0.1575	0.391627	0.366329
	2km	0.0279	1.17443	0.088846
North	1km	0.0513	0.391627	0.266257
North-West	1km	0.0657	0.399787	0.296766
	2km	0.0171	1.19915	0.06061
South	1km	0.1575	0.384401	0.365585
	2km	0.0378	1.17467	0.110582
South-East	1km	0.162	0.398853	0.365953
	2km	0.018	1.17499	0.064014
South-West	1km	0.1089	0.391627	0.355897
	2km	0.0603	1.17443	0.152451
	3km	0.0072	1.95815	0.020612
West	1km	0.1386	0.383468	0.367823
	2km	0.2268	1.15035	0.320135

Table 8.4.3: Shanon's Entropy Index Calculator – Pujali, 2011

	Distance	Urban Area	Total Area	Shanon
East	1km	0.2538	0.398924	0.28771
	2km	0.1557	1.19945	0.26503
North-East	1km	0.2673	0.391627	0.260687
	2km	0.0351	1.17443	0.104913
North	1km	0.1035	0.391627	0.35169
North-West	1km	0.0855	0.399787	0.329867
	2km	0.036	1.19915	0.10525
South	1km	0.1503	0.384401	0.367168
	2km	0.0063	1.17467	0.02804
South-East	1km	0.153	0.398853	0.367548

	2km	0.0153	1.17499	0.056528
South-West	1km	0.0585	0.391627	0.284008
	2km	0.0603	1.17443	0.152451
	3km	0.0063	1.95815	0.018465
West	1km	0.0954	0.383468	0.3461
	2km	0.3024	1.15035	0.351222

Table 8.4.4: Shanon's Entropy Index Calculator – Pujali, 2021

Direction	Distance	Urban Area	Total Area	Shanon Index
East	1km	0.2556	0.398924	0.2852227
	2km	0.3024	1.19945	0.34738189
North-East	1km	0.1674	0.391627	0.363297799
	2km	0.0378	1.17443	0.110597873
North	1km	0.1359	0.391627	0.367276193
North-West	1km	0.2178	0.399787	0.330880825
	2km	0.0747	1.19915	0.172921524
South	1km	0.1098	0.384401	0.357913292
	2km	0.0054	1.17467	0.024742826
South-East	1km	0.1026	0.398853	0.349265676
	2km	0.0432	1.17499	0.121445404
South-West	1km	0.1584	0.391627	0.366117561
	2km	0.1953	1.17443	0.298330651
	3km	0.0126	1.95815	0.032469596
West	1km	0.1692	0.383468	0.361008387
	2km	0.4995	1.15035	0.362228761

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11 Addendum:

Incorporation of additional data, made in thesis report as per recommendations:

Comments	Supportive data/clarification provided
c.) Literature and Case Study: Extensive literature study has been done in terms of contextual study, identifying model, guidelines and policies, and selection of case study is appropriate. Only concern is, the literature lacks proper referencing specially for the identified indicators. I suggest citing the references for clear understanding.	In section 2.1.2 Urbanisation, Urbanisation indicators and LULC change under Chapter 2: Literature review and case study appropriate sources have been added to figure no. 2.4 and 2.5
d.) Materials and methods: The use of GIS and Secondary data source to study the changes in the Periurban area and analysis based on LULC change, Shannon's Entropy and Urbanistic Calculation by Chi Square is good. The population 2021 data source has to be mentioned and justified.	There are various factors affecting the increase or decrease of population in a city, town or villages. Factors affecting changes in population are: • increase due to births • decrease due to deaths • increase/ decrease due to migration • increase due to annexation. The present and past population record for the city can be obtained from the census population records. After collecting these population figures, the population at the end of design period is predicted using various methods as suitable for that city considering the growth pattern followed by the city. Source: Module – 5, Lecture Number-05 M.M. Ghangrekar, IIT Kharagpur Module 5: Population Forecasting, In this research the following three methods are considered for determining the projected population in West Bengal to its micro level study areas. 1. Arithmetical Increase Method 2. Geometrical Increase Method 3. Incremental Increase Method Test run has been done with all these three models for finding out the suitable method giving closer value to any known decade. The nearest data delivering method was proved to be the incremental increase method. Hence the same has been chosen to calculate the population projection of 2021 manually for this thesis. This method is also adopted by Census of India, as has been confirmed by their officials.

e.) Results and discussions: The result discusses the guidelines for growth, governance, and globalisation. Relate the guidelines proposed with your findings. The composite score analysis is done to create map for all urbanisation indicators is good, the correlation is positive with few indices of urbanisation, but very weak, the correlation graph can be added. The growth direction using shannon's entropy is appreciable.	a) added section 7.2 Relating guidelines with research findings of micro level areas in chapter 7 with Figure 7. 12: Immediate interventions/ policy framing in the un-saturated areas/zones Source: Prepared by author b) in chapeter 6 , under section, section 6.2 and further to subsection 6.2.1 composite score mappings have been added as 6.2.1.2 Correlation -Composite Score Mapping of urbanization indicators in unsaturated areas also correlation graphs have been added in 6.2.1.3 comparison of urbanization indicators (correlation) of un-saturated areas with KMA and KMC.
f) Conclusion and new findings: The use of three different models to map the Periurban area and further examination about the growth dynamics of the areas has been done. Also the effect of physical change in the peri-urban areas, due to human settlement have been discussed. The further research for sustainable planning guidelines for peri-urban area has been suggested. It has been observed that the change in the urban green open space in these areas and effect of socio-economic impact on human settlement can be added in the future research work.	Two questions added in the scope of further research ☐ How to measure loss of urban green open space in peri-urban areas and preservative guidelines can be formed? ☐ How to deal with socio-economic impact on human settlements in the peri-urban areas, during the time of changes?